ELEMENTARY

CORE Academy

UTAH STATE OFFICE OF EDUCATION & UTAH STATE UNIVERSITY

ELEMENTARY CORE ACADEMY • ELEMENTARY CORE ACADEMY • ELEMENTARY

6TH GRADE

2008 Participant Handbook

UTAH STATE OFFICE OF EDUCATION

UtahState UNIVERSITY

ELEMENTARY CORE ACADEMY
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Organizations:

Utah State Office of Education (USOE)
Utah State University (USU)
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State Mathematics Education Coordination Committee (SMECC)
Special Education Services Unit (USOE)

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UTAH STATE OFFICE OF EDUCATION

Leadership…Service…Accountability

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Dear CORE Academy Teachers:

Thank you for your investment in children and in building your own expertise as you participate in the Elementary CORE Academy. I hope your involvement helps you to sustain a laser-like focus on student achievement.

Teachers in Utah are superb. By participating in the Academy, you join a host of teachers throughout the state who understand that teaching targeted on the core curricula, across a spectrum of subjects, will produce results of excellence. The research is quite clear–the closer the match of explicit instruction to core standards, the better the outcome on core assessments.

I personally appreciate your excellence and your desire to create wonderful classrooms of learning for students. Thank you for your dedication. I feel honored to associate with you and pledge my support to lead education in ways that benefit all of our children.

Sincerely,

Patti Harrington

Patti Harrington, Ed.D.
State Superintendent of Public Instruction

Funding Sources

Appreciation is expressed for the tremendous educational input and monetary commitment of several organizations for the successful delivery of the Elementary CORE Academy. This year's Elementary CORE Academy was developed and funded through a variety of sources. The Utah State Office of Education (USOE), in collaboration with Utah State University (USU) and local school districts of Utah, have supported kindergarten through sixth grade teachers with professional development experiences that will enhance the educational experience for Utah children.

Major funding for the Academy comes from the following sources:

Federal/State Funds:

Utah State Office of Education
- Staff Development Funds
- Special Education Services Unit

ESEA Title II

Utah Math Science Partnership

District Funds:

Various sources including Quality Teacher Block, Federal ESEA Title II, and District Professional Development Funds

School Funds:

Trust land, ESEA Title II, and other school funds
Utah State Office of Education Special Education Services

The state and district funds are allocations from the state legislature. ESEA is part of the "No Child Left Behind" funding that comes to Utah.

Additionally, numerous school districts, individual schools, and principals in Utah have sponsored teachers to attend the Academy. Other educational groups have assisted in the development and delivery of resources in the Academy.

Most important is the thousands of teachers who take time from their summer to attend these professional development workshops. It is these teachers who make this program possible.

Goals of the Elementary CORE Academy

Overall

The purpose of the Elementary CORE Academy is to create high quality teacher instruction and improve student achievement through the delivery of professional development opportunities and experiences for teachers across Utah.

The Academy will provide elementary teachers in Utah with:

1. Models of exemplary and innovative instructional strategies, tools, and resources to meet the Core Curriculum standards, objectives, and indicators.
2. Practical models and diverse methods of meeting the learning needs of all children, with instruction implementation aligned to the Core Curriculum.
3. Meaningful opportunities for collaboration, self-reflection, and peer discussion specific to innovative and effective instructional techniques, materials, teaching strategies, and professional practices in order to improve classroom instruction.

Learning a limited set of facts will no longer prepare a student for real experiences encountered in today's world. It is imperative that educators have continued opportunities to obtain instructional skills and strategies that provide methods of meeting the needs of all students. Participants of the Academy experience will be better equipped to meet the challenges faced in today's classrooms.

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Utah Elementary Math Core Curriculum

Introduction

Most children enter school confident in their own abilities; they are curious and eager to learn more. They make sense of the world by reasoning and problem solving. Young students are building beliefs about what mathematics is, about what it means to know and do mathematics, and about themselves as mathematical learners. Students use mathematical tools, such as manipulative materials and technology, to develop conceptual understanding and solve problems as they do mathematics. Students, as mathematicians, learn best through participatory experiences throughout the instruction of the mathematics curriculum.

Recognizing that no term captures completely all aspects of expertise, competence, knowledge, and facility in mathematics, the term *mathematical proficiency* has been chosen to capture what it means to learn mathematics successfully. Mathematical proficiency has five strands: computing (carrying out mathematical procedures flexibly, accurately, efficiently, and appropriately), understanding (comprehending mathematical concepts, operations, and relations), applying (ability to formulate, represent, and solve mathematical problems), reasoning (logically explaining and justifying a solution to a problem), and engaging (seeing mathematics as sensible, useful, and doable, and being able to do the work) (NRC, 2001).

The most important observation about the five strands of mathematical proficiency is that they are interwoven and interdependent. This observation has implications for how students acquire mathematical proficiency, how teachers develop that proficiency in their students, and how teachers are educated to achieve that goal. At any given moment during a mathematics lesson or unit, one or two strands might be emphasized. But all the strands must eventually be addressed so that the links among them are strengthened. The integrated and balanced development of all five strands of mathematical proficiency should guide the teaching and learning of school mathematics. Instruction should not be based on the extreme positions that students learn solely by internalizing what a teacher or book says, or solely by inventing mathematics on their own.

The Elementary Mathematics Core describes what students should know and be able to do at the end of each of the K-6 grade levels. It was developed and revised by a community of Utah mathematics teachers, mathematicians, university mathematics educators, and

State Office of Education specialists. It was critiqued by an advisory committee representing a wide variety of people from the community, as well as an external review committee. The Core reflects the current philosophy of mathematics education that is expressed in national documents developed by the National Council of Teachers of Mathematics, the American Association for the Advancement of Science, and the National Research Council. This Mathematics Core has the endorsement of the Utah Council of Teachers of Mathematics. The Core reflects high standards of achievement in mathematics for all students.

Organization of the Elementary Mathematics Core

The Core is designed to help teachers organize and deliver instruction.

- Each grade level begins with a brief description of areas of instructional emphasis which can serve as organizing structures for curriculum design and instruction.
- The INTENDED LEARNING OUTCOMES (ILOs) describe the skills and attitudes students should acquire as a result of successful mathematics instruction. They are found at the beginning of each grade level and are an integral part of the Core.
- A STANDARD is a broad statement of what students are expected to understand. Several Objectives are listed under each Standard.
- An OBJECTIVE is a more focused description of what students need to know and be able to do at the completion of instruction. If students have mastered the Objectives associated with a given Standard, they have mastered that Standard at that grade level. Several Indicators are described for each Objective.
- INDICATORS are observable or measurable student actions that enable students to master an Objective. Indicators can help guide classroom instruction.
- MATHEMATICAL LANGUAGE AND SYMBOLS STUDENTS SHOULD USE includes language and symbols students should use in oral and written language.
- EXPLORATORY CONCEPTS AND SKILLS are included to establish connections with learning in subsequent grade levels. They are not intended to be assessed at the grade level indicated.

Guidelines Used in Developing the Elementary Mathematics Core

The Core is:

Consistent With the Nature of Learning

In the early grades, children are forming attitudes and habits for learning. It is important that instruction maximizes students' potential and gives them understanding of the intertwined nature of learning. The main intent of mathematics instruction is for students to value and use mathematics as a process to understand the world. The Core is designed to produce an integrated set of Intended Learning Outcomes for students.

Coherent

The Core has been designed so that, wherever possible, the ideas taught within a particular grade level have a logical and natural connection with each other and with those of earlier grades. Efforts have also been made to select topics and skills that integrate well with one another and with other subject areas appropriate to grade level. In addition, there is an upward articulation of mathematical concepts and skills. This spiraling is intended to prepare students to understand and use more complex mathematical concepts and skills as they advance through the learning process.

Developmentally Appropriate

The Core takes into account the psychological and social readiness of students. It builds from concrete experiences to more abstract understandings. The Core focuses on providing experiences with concepts that students can explore and understand in depth to build the foundation for future mathematical learning experiences.

Reflective of Successful Teaching Practices

Learning through play, movement, and adventure is critical to the early development of the mind and body. The Core emphasizes student exploration. The Core is designed to encourage a variety of interactive learning opportunities. Instruction should include recognition of the role of mathematics in the classroom, school, and community.

Comprehensive

By emphasizing depth rather than breadth, the Elementary Mathematics Core seeks to empower students by providing a comprehensive background in mathematics. Teachers are expected to teach all the standards and objectives specified in the Core for their grade level, but may add related concepts and skills.

Feasible

Teachers and others who are familiar with Utah students, classrooms, teachers, and schools have designed the Core. It can be taught with easily obtained resources and materials. A handbook is also available for teachers and has sample lessons on each topic for each grade level. The handbook is a document that will grow as teachers add exemplary lessons aligned with the new Core.

Useful and Relevant

This curriculum relates directly to student needs and interests. The relevance of mathematics to other endeavors enables students to transfer skills gained from mathematics instruction into their other school subjects and into their lives outside the classroom.

Reliant Upon Effective Assessment Practices

Student achievement of the standards and objectives in this Core is best assessed using a variety of assessment instruments. Performance tests are particularly appropriate to evaluate student mastery of mathematical processes and problem-solving skills. Teachers should use a variety of classroom assessment approaches in conjunction with standard assessment instruments to inform instruction. Sample test items, keyed to each Core Standard, may be located on the "Utah Mathematics Home Page" at http://www.usoe.k12.ut.us/curr/math. Observation of students engaged in instructional activities is highly recommended as a way to assess students' skills as well as attitudes toward learning. The nature of the questions posed by students provides important evidence of their understanding of mathematics.

Based Upon the National Council of Teachers of Mathematics Curriculum Focal Points

In 2006, the National Council of Teachers of Mathematics (NCTM) published ***Curriculum Focal Points for Prekindergarten through Grade 8 Mathematics*** (NCTM, 2006). This document is available online at http://www.nctm.org/focalpoints. This document describes three focal points for each grade level. NCTM's focal points are areas of emphasis recommended for the curriculum of each grade level. The focal points within a grade are ***not the entire curriculum*** for that particular grade; however, Utah's Core Curriculum was designed to include these areas of focus.

Intended Learning Outcomes for Third through Sixth Grade Mathematics

The main intent of mathematics instruction is for students to value and use mathematics and reasoning skills to investigate and understand the world.

The Intended Learning Outcomes (ILOs) describe the skills and attitudes students should acquire as a result of successful mathematics instruction. They are an essential part of the Mathematics Core Curriculum and provide teachers with a standard for student learning in mathematics.

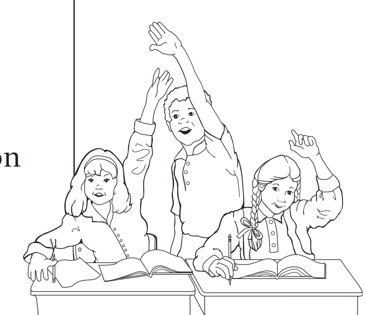
ILOs for mathematics:

1. **Develop a positive learning attitude toward mathematics.**
2. **Become effective problem solvers by selecting appropriate methods, employing a variety of strategies, and exploring alternative approaches to solve problems.**
3. **Reason logically, using inductive and deductive strategies and justify conclusions.**
4. **Communicate mathematical ideas and arguments coherently to peers, teachers, and others using the precise language and notation of mathematics.**
5. **Connect mathematical ideas within mathematics, to other disciplines, and to everyday experiences.**
6. **Represent mathematical ideas in a variety of ways.**

Significant mathematics understanding occurs when teachers incorporate ILOs in planning mathematics instruction. The following are ideas to consider when planning instruction for students to acquire the ILOs:

1. **Develop a positive learning attitude toward mathematics.**

   When students are confident in their mathematical abilities, they demonstrate persistence in completing tasks. They pose mathematical questions about objects, events, and processes while displaying a sense of curiosity about numbers and patterns. It is important to build on students' innate problem-solving inclinations and to preserve and encourage a disposition that values mathematics.



2. **Become effective problem solvers by selecting appropriate methods, employing a variety of strategies, and exploring alternative approaches to solve problems.**

   Problem solving is the cornerstone of mathematics. Mathematical knowledge is generated through problem solving as students explore mathematics. To become effective problem solvers, students need many opportunities to formulate questions and model problem situations in a variety of ways. They should generalize mathematical relationships and solve problems in both mathematical and everyday contexts.

3. **Reason logically, using inductive and deductive strategies and justify conclusions.**

   Mathematical reasoning develops in classrooms where students are encouraged to put forth their own ideas for examination. Students develop their reasoning skills by making and testing mathematical conjectures, drawing logical conclusions, and justifying their thinking in developmentally appropriate ways. Students use models, known facts, and relationships to explain reasoning. As they advance through the grades, students' arguments become more sophisticated.

4. **Communicate mathematical ideas and arguments coherently to peers, teachers, and others using the precise language and notation of mathematics.**

   The ability to express mathematical ideas coherently to peers, teachers, and others through oral and written language is an important skill in mathematics. Students develop this skill and deepen their understanding of mathematics when they use accurate mathematical language to talk and write about what they are doing. When students talk and write about mathematics, they clarify their ideas and learn how to make convincing arguments and represent mathematical ideas verbally, pictorially, and symbolically.

5. **Connect mathematical ideas within mathematics, to other disciplines, and to everyday experiences.**

   Students develop a perspective of the mathematics field as an integrated whole by understanding connections within mathematics. Students should be encouraged to explore the connections that exist with other disciplines and between mathematics and their own experiences.

6. **Represent mathematical ideas in a variety of ways.**

   Mathematics involves using various types of representations including concrete, pictorial, and symbolic models. In particular, identifying and locating numbers on the number line has a central role in uniting all numbers to promote understanding of equivalent representations and ordering. Students also use a variety of mathematical representations to expand their capacity to think logically about mathematics.

Sixth Grade Mathematics Standards

By the end of grade six, students have mastered the four arithmetic operations with whole numbers, positive rational numbers, positive decimals, and positive and negative integers; they accurately compute and solve problems. They find prime factorizations, least common multiples, and greatest common factors. They create, evaluate, and simplify expressions, and solve equations involving two operations and a single variable. They solve problems involving an unknown angle in a triangle or quadrilateral, and use properties of complementary and supplementary angles. Students know about π as the ratio between the circumference and the diameter of a circle and solve problems using the formulas for the circumference and area of a circle. Students analyze, draw conclusions, and make predictions based upon data and apply basic concepts of probability.

Standard I: **Students will expand number sense to include operations with rational numbers.**

Objective 1: Represent rational numbers in a variety of ways.

a. Recognize a rational number as a ratio of two integers, a to b, where b is not equal to zero.
b. Change whole numbers with exponents to standard form (e.g., $2^4 = 16$) and recognize that any non-zero whole number to the zero power equals 1 (e.g., $9^0 = 1$).
c. Write a whole number in expanded form using exponents (e.g., $876{,}539 = 8 \times 10^5 + 7 \times 10^4 + 6 \times 10^3 + 5 \times 10^2 + 3 \times 10^1 + 9 \times 10^0$).
d. Express numbers in scientific notation using positive powers of ten.

Objective 2: Explain relationships and equivalencies among rational numbers.

a. Place rational numbers on the number line.
b. Compare and order rational numbers, including positive and negative mixed fractions and decimals, using a variety of methods and symbols, including the number line and finding common denominators.
c. Find equivalent forms for common fractions, decimals, percents, and ratios, including repeating or terminating decimals.

Standard I:
Students will expand number sense to include operations with rational numbers.

d. Relate percents less than 1% or greater than 100% to equivalent fractions, decimals, whole numbers, and mixed numbers.

e. Recognize that the sum of an integer and its additive inverse is zero.

Objective 3: Use number theory concepts to find prime factorizations, least common multiples, and greatest common factors.

a. Determine whether whole numbers to 100 are prime, composite, or neither.

b. Find the prime factorization of composite numbers to 100.

c. Find the greatest common factor and least common multiple for two numbers using a variety of methods (e.g., list of multiples, prime factorization).

Objective 4: Model and illustrate meanings of operations and describe how they relate.

a. Relate fractions to multiplication and division and use this relationship to explain procedures for multiplying and dividing fractions.

b. Recognize that ratios derive from pairs of rows in the multiplication table and connect with equivalent fractions.

c. Give mixed number and decimal solutions to division problems with whole numbers.

Objective 5: Solve problems involving multiple steps.

a. Select appropriate methods to solve a multi-step problem involving multiplication and division of fractions and decimals.

b. Use estimation to determine whether results obtained using a calculator are reasonable.

c. Use estimation or calculation to compute results, depending on the context and numbers involved in the problem.

d. Solve problems involving ratios and proportions.

Objective 6: Demonstrate proficiency with the four operations, with positive rational numbers, and with addition and subtraction of integers.

a. Multiply and divide a multi-digit number by a two-digit number, including decimals.

b. Add, subtract, multiply, and divide fractions and mixed numbers.

c. Add and subtract integers.

Mathematical language and symbols students should use:

prime, composite, exponent, least common multiple, least common denominator, greatest common factor, decimals, percents, divisible, divisibility, equivalent fractions, integer, dividend, quotient, divisor, factor, simplest terms, mixed numeral, improper fraction

Exploratory Concepts and Skills

- Explore the addition and subtraction of positive and negative fractions.
- Investigate the concepts of ratio and proportion.
- Investigate the distributive property of multiplication over addition of double-digit multipliers.

Standard II: **Students will use patterns, relations, and algebraic expressions to represent and analyze mathematical problems and number relationships.**

Objective 1: Analyze algebraic expressions, tables, and graphs to determine patterns, relations, and rules.

a. Describe simple relationships by creating and analyzing tables, equations, and expressions.

b. Draw a graph and write an equation from a table of values.

c. Draw a graph and create a table of values from an equation.

Objective 2: Write, interpret, and use mathematical expressions, equations, and formulas to represent and solve problems that correspond to given situations.

a. Solve single variable linear equations using a variety of strategies.

b. Recognize that expressions in different forms can be equivalent and rewrite an expression to represent a quantity in a different way.

c. Evaluate and simplify expressions and formulas, substituting given values for the variables (e.g., 2x + 4; x = 2; therefore, 2 (2) + 4 = 8).

Mathematical language and symbols students should use:
order of operations, sequence, function, pattern, algebraic expression, approximately equal, ≈, notation for exponents: 4^3 or 4^3, a number in front of a variable indicates multiplication (e.g., 3y means 3 times the quantity y), formula, generalization

Exploratory Concepts and Skills
- Use physical models to investigate and describe how a change in one variable affects a second variable.
- Use models to develop understanding of slope as constant rate of change.
- Model situations with proportional relationships and solve problems.

Standard II: Students will use patterns, relations, and algebraic expressions to represent and analyze mathematical problems and number relationships.

Standard III: Students will use spatial and logical reasoning to recognize, describe, and analyze geometric shapes and principles.

Objective 1: Identify and analyze attributes and properties of geometric shapes to solve problems.

a. Identify the midpoint of a line segment and the center and circumference of a circle.

b. Identify angles as vertical, adjacent, complementary, or supplementary and provide descriptions of these terms.

c. Develop and use the properties of complementary and supplementary angles and the sum of the angles of a triangle to solve problems involving an unknown angle in a triangle or quadrilateral.

Objective 2: Visualize and identify geometric shapes after applying transformations on a coordinate plane.

a. Rotate a polygon about the origin by a multiple of 90° and identify the location of the new vertices.

b. Translate a polygon either horizontally or vertically on a coordinate grid and identify the location of the new vertices.

c. Reflect a polygon across either the x- or y-axis and identify the location of the new vertices.

Mathematical language and symbols students should use:
midpoint, circumference, complementary and supplementary angles, rotate, translate, reflect, transformation

Exploratory Concepts and Skills

- Use manipulatives and technology to model geometric shapes.
- Investigate tessellations.
- Explore the angles formed by intersecting lines.
- Identify and draw shapes and figures from different views/perspectives.

Standard III:
Students will use spatial and logical reasoning to recognize, describe, and analyze geometric shapes and principles.

Standard IV:
Students will understand and apply measurement tools and techniques and find the circumference and area of a circle.

Standard IV: Students will understand and apply measurement tools and techniques and find the circumference and area of a circle.

Objective 1: Describe and find the circumference and area of a circle.

a. Explore the relationship between the radius and diameter of a circle to the circle's circumference to develop the formula for circumference.

b. Find the circumference of a circle using a formula.

c. Describe pi as the ratio of the circumference to the diameter of a circle.

d. Decompose a circle into a number of wedges and rearrange the wedges into a shape that approximates a parallelogram to develop the formula for the area of a circle.

e. Find the area of a circle using a formula.

Objective 2: Identify and describe measurable attributes of objects and units of measurement, and solve problems involving measurement.

a. Recognize that measurements are approximations and describe how the size of the unit used in measuring affects the precision.

b. Convert units of measurement within the metric system and convert units of measurement within the customary system.

c. Compare a meter to a yard, a liter to a quart, and a kilometer to a mile.

d. Determine when it is appropriate to estimate or use precise measurement when solving problems.

e. Derive and use the formula to determine the surface area and volume of a cylinder.

Mathematical language and symbols students should use:
cylinder, radius, diameter, circumference, area, surface area, volume, π

Exploratory Concepts and Skills
- Investigate volumes and surface areas of a variety of three-dimensional objects.

Standard V: Students will analyze, draw conclusions, and make predictions based upon data and apply basic concepts of probability.

Objective 1: Design investigations to reach conclusions using statistical methods to make inferences based on data.

a. Design investigations to answer questions.
b. Extend data display and comparisons to include scatter plots and circle graphs.
c. Compare two similar sets of data on the same graph and compare two graphs representing the same set of data.
d. Recognize that changing the scale influences the appearance of a display of data.
e. Propose and justify inferences and predictions based on data.

Objective 2: Apply basic concepts of probability and justify outcomes.

a. Write the results of a probability experiment as a fraction between zero and one, or an equivalent percent.
b. Compare experimental results with theoretical results (e.g., experimental: 7 out of 10 tails; whereas, theoretical 5 out of 10 tails).
c. Compare individual, small group, and large group results of a probability experiment in order to more accurately estimate the actual probabilities.

Mathematical language and symbols students should use:
data display, scatter plot, circle graph, scale, predict, justify, probability, experimental results, theoretical results

Exploratory Concepts and Skills
- Investigate the notion of fairness in games.

Standard V:
Students will analyze, draw conclusions, and make predictions based upon data and apply basic concepts of probability.

Utah Elementary Science Core Curriculum

Introduction

Science is a way of knowing, a process for gaining knowledge and understanding of the natural world. The Science Core Curriculum places emphasis on understanding and using skills. Students should be active learners. It is not enough for students to read about science; they must do science. They should observe, inquire, question, formulate and test hypotheses, analyze data, report, and evaluate findings. The students, as scientists, should have hands–on, active experiences throughout the instruction of the science curriculum.

The Elementary Science Core describes what students should know and be able to do at the end of each of the K–6 grade levels. It was developed, critiqued, piloted, and revised by a community of Utah science teachers, university science educators, State Office of Education specialists, scientists, expert national consultants, and an advisory committee representing a wide variety of people from the community. The Core reflects the current philosophy of science education that is expressed in national documents developed by the American Association for the Advancement of Science, the National Academies of Science. This Science Core has the endorsement of the Utah Science Teachers Association. The Core reflects high standards of achievement in science for all students.

Organization of the Elementary Science Core

The Core is designed to help teachers organize and deliver instruction.

The Science Core Curriculum's organization:

- Each grade level begins with a brief course description.
- The INTENDED LEARNING OUTCOMES (ILOs) describe the goals for science skills and attitudes. They are found at the beginning of each grade, and are an integral part of the Core that should be included as part of instruction.
- The SCIENCE BENCHMARKS describe the science content students should know. Each grade level has three to five Science Benchmarks. The ILOs and Benchmarks intersect in the Standards, Objectives and Indicators.

- A STANDARD is a broad statement of what students are expected to understand. Several Objectives are listed under each Standard.
- An OBJECTIVE is a more focused description of what students need to know and be able to do at the completion of instruction. If students have mastered the Objectives associated with a given Standard, they are judged to have mastered that Standard at that grade level. Several Indicators are described for each Objective.
- An INDICATOR is a measurable or observable student action that enables one to judge whether a student has mastered a particular Objective. Indicators are not meant to be classroom activities, but they can help guide classroom instruction.

Guidelines Used in Developing the Elementary Science Core

Reflects the Nature of Science

Science is a way of knowing, a process of gaining knowledge and understanding of the natural world. The Core is designed to produce an integrated set of Intended Learning Outcomes (ILOs) for students. Please see the Intended Learning Outcomes document for each grade level core.

As described in these ILOs, students will:

1. Use science process and thinking skills.
2. Manifest science interests and attitudes.
3. Understand important science concepts and principles.
4. Communicate effectively using science language and reasoning.
5. Demonstrate awareness of the social and historical aspects of science.
6. Understand the nature of science.

Coherent

The Core has been designed so that, wherever possible, the science ideas taught within a particular grade level have a logical and natural connection with each other and with those of earlier grades. Efforts have also been made to select topics and skills that integrate well with one another and with other subject areas appropriate to grade level. In addition, there is an upward articulation of science concepts, skills, and content. This spiraling is intended to prepare students to understand and use more complex science concepts and skills as they advance through their science learning.

The Core is:

- Coherent
- Developmentally Appropriate
- Encourages Good Teaching Practices
- Comprehensive
- Feasible
- Useful and Relevant
- Encourages Good Assessment Practice

Developmentally Appropriate

The Core takes into account the psychological and social readiness of students. It builds from concrete experiences to more abstract understandings. The Core describes science language students should use that is appropriate to each grade level. A more extensive vocabulary should not be emphasized. In the past, many educators may have mistakenly thought that students understood abstract concepts (such as the nature of the atom), because they repeated appropriate names and vocabulary (such as electron and neutron). The Core resists the temptation to tell about abstract concepts at inappropriate grade levels, but focuses on providing experiences with concepts that students can explore and understand in depth to build a foundation for future science learning.

Encourages Good Teaching Practices

It is impossible to accomplish the full intent of the Core by lecturing and having students read from textbooks. The Elementary Science Core emphasizes student inquiry. Science process skills are central in each standard. Good science encourages students to gain knowledge by doing science: observing, questioning, exploring, making and testing hypotheses, comparing predictions, evaluating data, and communicating conclusions. The Core is designed to encourage instruction with students working in cooperative groups. Instruction should connect lessons with students' daily lives. The Core directs experiential science instruction for all students, not just those who have traditionally succeeded in science classes. The vignettes listed on the "Utah Science Home Page" at http:// www.usoe.k12.ut.us/curr/science for each of the Core standards provide examples, based on actual practice, that demonstrate that excellent teaching of the Science Core is possible.

Comprehensive

The Elementary Science Core does not cover all topics that have traditionally been in the elementary science curriculum; however, it does provide a comprehensive background in science. By emphasizing depth rather than breadth, the Core seeks to empower students rather than intimidate them with a collection of isolated and eminently forgettable facts. Teachers are free to add related concepts and skills, but they are expected to teach all the standards and objectives specified in the Core for their grade level.

Feasible

Teachers and others who are familiar with Utah students, classrooms, teachers, and schools have designed the Core. It can be taught with easily obtained resources and materials. A handbook is also available for teachers and has sample lessons on each topic for each grade level. The handbook is a document that will grow as teachers add exemplary lessons aligned with the new Core.

Useful and Relevant

This curriculum relates directly to student needs and interests. It is grounded in the natural world in which we live. Relevance of science to other endeavors enables students to transfer skills gained from science instruction into their other school subjects and into their lives outside the classroom.

Encourages Good Assessment Practices

Student achievement of the standards and objectives in this Core are best assessed using a variety of assessment instruments. One's purpose should be clearly in mind as assessment is planned and implemented. Performance tests are particularly appropriate to evaluate student mastery of science processes and problem-solving skills. Teachers should use a variety of classroom assessment approaches in conjunction with standard assessment instruments to inform their instruction. Sample test items, keyed to each Core Standard, may be located on the Utah Science Home Page. Observation of students engaged in science activities is highly recommended as a way to assess students' skills as well as attitudes in science. The nature of the questions posed by students provides important evidence of students' understanding of science.

The Most Important Goal

Elementary school reaches the greatest number of students for a longer period of time during the most formative years of the school experience. Effective elementary science instruction engages students actively in enjoyable learning experiences. Science instruction should be as thrilling an experience for a child as seeing a rainbow, growing a flower, or holding a toad. Science is not just for those who have traditionally succeeded in the subject, and it is not just for those who will choose science-related careers. In a world of rapidly expanding knowledge and technology, all students must gain the skills they will need to understand and function responsibly and successfully in the world. The Core provides skills in a context that enables students to experience the joy of doing science.

Sixth Grade Science Core Curriculum

- Design and perform experiments
- Value inquiry
- Maintain an open questioning mind
- Pose questions about objects, events, processes, and results
- Plan and conduct experiments
- Read, observe, compare, describe, infer, and draw conclusions
- Formalize the process of science
- Identify variables in a formal experiment

The theme for Sixth Grade Science is Scale, with Relative Position as an underlying concept. Sixth graders should begin to relate to the incredible size and distance of objects in the solar system, galaxy, and universe, as well as compare their world to the miniscule scale of microorganisms. Students will also understand how relative position affects such events as the appearance of the moon and the changing of the seasons. Students will experiment with heat, light, and sound, and begin to understand concepts of energy.

Students should begin to design and perform experiments and value inquiry as the fundamental scientific process. They should be encouraged to maintain an open and questioning mind as they plan and conduct experiments. They should be helped and encouraged to pose their own questions about objects, events, processes, and results. They should have the opportunity to plan and conduct their own experiments, and come to their own conclusions as they read, observe, compare, describe, infer, and draw conclusions. The results of their experiments need to be compared for reasonableness to multiple sources of information. It is important for students at this age to begin to formalize the processes of science and be able to identify the variables in a formal experiment.

Good science instruction requires hands–on science investigations in which student inquiry is an important goal. Teachers should provide opportunities for all students to experience many things. Sixth graders should experience the excitement of locating the North Star and Little Dipper, and the wonders of gazing into the night sky. They should find the fascination of peering into the world of microorganisms, experimenting and watching them as they move and feed and reproduce. Students should come to enjoy science as a process of discovering the natural world.

Science Core concepts should be integrated with concepts and skills from other curriculum areas. Reading, writing, and mathematics skills should be emphasized as integral to the instruction of science. Technology issues and the nature of science are significant components of this Core. Personal relevance of science in students' lives is always an important part of helping students to value science, and should be emphasized at this grade level.

This Core was designed using the American Association for the Advancement of Science's Project 2061: Benchmarks For Science Literacy and the National Academy of Science's National Science

Education Standards as guides to determine appropriate content and skills.

The sixth grade Science Core has three online resources designed to help with classroom instruction; they include Teacher Resource Book –a set of lesson plans, assessment items and science information specific to sixth grade; Sci-ber Text –an electronic science textbook specific to the Utah Core; and the science test item pool. This pool includes multiple-choice questions, performance tasks, and interpretive items aligned to the standards and objectives of the sixth grade Science Core. These resources are all available on the Utah Science Home Page at http://www.usoe.k12.ut.us/curr/science.

SAFETY PRECAUTIONS

The hands–on nature of this science curriculum increases the need for teachers to use appropriate precautions in the classroom and field. Proper handling and disposal of microorganisms is crucial for a safe classroom. Teachers must adhere to the published guidelines for the proper use of animals, equipment, and chemicals in the classroom. These guidelines are available on the Utah Science Home Page.

Intended Learning Outcomes for Sixth Grade Science

- Use Science Process and Thinking Skills
- Manifest Scientific Attitudes and Interests
- Understand Science Concepts and Principles
- Communicate Effectively Using Science Language and Reasoning
- Demonstrate Awareness of Social and Historical Aspects of Science
- Understand the Nature of Science

The Intended Learning Outcomes (ILOs) describe the skills and attitudes students should learn as a result of science instruction. They are an essential part of the Science Core Curriculum and provide teachers with a standard for evaluation of student learning in science. Instruction should include significant science experiences that lead to student understanding using the ILOs.

The main intent of science instruction in Utah is that students will value and use science as a process of obtaining knowledge based upon observable evidence.

By the end of sixth grade students will be able to:

1. Use Science Process and Thinking Skills
   a. Observe simple objects, patterns, and events, and report their observations.
   b. Sort and sequence data according to criteria given.
   c. Given the appropriate instrument, measure length, temperature, volume, and mass in metric units as specified.
   d. Compare things, processes, and events.
   e. Use classification systems.
   f. Plan and conduct simple experiments.
   g. Formulate simple research questions.
   h. Predict results of investigations based on prior data.
   i. Use data to construct a reasonable conclusion.
2. Manifest Scientific Attitudes and Interests
   a. Demonstrate a sense of curiosity about nature.
   b. Voluntarily read and look at books and other materials about science.
   c. Pose science questions about objects, events, and processes.
   d. Maintain an open and questioning mind toward new ideas and alternative points of view.
   e. Seek and weigh evidence before drawing conclusions.
   f. Accept and use scientific evidence to help resolve ecological problems.
3. Understand Science Concepts and Principles

   a. Know and explain science information specified for the grade level.
   b. Distinguish between examples and non-examples of concepts that have been taught.
   c. Solve problems appropriate to grade level by applying science principles and procedures.

4. Communicate Effectively Using Science Language and Reasoning
   a. Record data accurately when given the appropriate form (e.g., table, graph, chart).
   b. Describe or explain observations carefully and report with pictures, sentences, and models.
   c. Use scientific language in oral and written communication.
   d. Use reference sources to obtain information and cite the source.
   e. Use mathematical reasoning to communicate information.
5. Demonstrate Awareness of Social and Historical Aspects of Science
   a. Cite examples of how science affects life.
   b. Understand the cumulative nature of science knowledge.
6. Understand the Nature of Science
   a. Science is a way of knowing that is used by many people not just scientists.
   b. Understand that science investigations use a variety of methods and do not always use the same set of procedures; understand that there is not just one "scientific method."
   c. Science findings are based upon evidence.

Sixth Grade Science Standards

Science Benchmark

The appearance of the lighted portion of the moon changes in a predictable cycle as a result of the relative positions of Earth, the moon, and the Sun. Earth turns on an axis that is tilted relative to the plane of Earth's yearly orbit. The tilt causes Sunlight to fall more intensely on different parts of the Earth during various parts of the year. The differences in heating of Earth's surface and length of daylight hours produce the seasons.

Standard I:
Students will understand that the appearance of the moon changes in a predictable cycle as it orbits Earth and as Earth rotates on its axis.

Standard I: Students will understand that the appearance of the moon changes in a predictable cycle as it orbits Earth and as Earth rotates on its axis.

Objective 1: Explain patterns of changes in the appearance of the moon as it orbits Earth.

a. Describe changes in the appearance of the moon during a month.
b. Identify the pattern of change in the moon's appearance.
c. Use observable evidence to explain the movement of the moon around Earth in relationship to Earth turning on its axis and the position of the moon changing in the sky.
d. Design an investigation, construct a chart, and collect data depicting the phases of the moon.

Objective 2: Demonstrate how the relative positions of Earth, the moon, and the Sun create the appearance of the moon's phases.

a. Identify the difference between the motion of an object rotating on its axis and an object revolving in orbit.
b. Compare how objects in the sky (the moon, planets, stars) change in relative position over the course of the day or night.
c. Model the movement and relative positions of Earth, the moon, and the Sun.

Standard II: Students will understand how Earth's tilt on its axis changes the length of daylight and creates the seasons.

Objective 1: Describe the relationship between the tilt of Earth's axis and its yearly orbit around the Sun.

a. Describe the yearly revolution (orbit) of Earth around the Sun.

b. Explain that Earth's axis is tilted relative to its yearly orbit around the Sun.

c. Investigate the relationship between the amount of heat absorbed and the angle to the light source.

Objective 2: Explain how the relationship between the tilt of Earth's axis and its yearly orbit around the Sun produces the seasons.

a. Compare Earth's position in relationship to the Sun during each season.

b. Compare the hours of daylight and illustrate the angle that the Sun's rays strikes the surface of Earth during summer, fall, winter, and spring in the Northern Hemisphere.

c. Use collected data to compare patterns relating to seasonal daylight changes.

d. Use a drawing and/or model to explain that changes in the angle at which light from the Sun strikes Earth, and the length of daylight, determine seasonal differences in the amount of energy received.

e. Use a model to explain why the seasons are reversed in the Northern and Southern Hemispheres.

Science language students should use:

Earth's tilt, seasons, axis of rotation, orbits, phases of the moon, revolution, reflection

Standard II:
Students will understand how Earth's tilt on its axis changes the length of daylight and creates the seasons.

Science Benchmark

The solar system consists of planets, moons, and other smaller objects including asteroids and comets that orbit the Sun. Planets in the solar system differ in terms of their distance from the Sun, number of moons, size, composition, and ability to sustain life. Every object exerts gravitational force on every other object depending on the mass of the objects and the distance between them. The Sun's gravitational pull holds Earth and other planets in orbit. Earth's gravitational force holds the moon in orbit. The Sun is one of billions of stars in the Milky Way galaxy, that is one of billions of galaxies in the universe. Scientists use a variety of tools to investigate the nature of stars, galaxies, and the universe. Historically, cultures have observed objects in the sky and understood and used them in various ways.

Standard III: Students will understand the relationship and attributes of objects in the solar system.

Standard III: Students will understand the relationship and attributes of objects in the solar system.

Objective 1: Describe and compare the components of the solar system.

a. Identify the planets in the solar system by name and relative location from the Sun.

b. Using references, compare the physical properties of the planets (e.g., size, solid or gaseous).

c. Use models and graphs that accurately depict scale to compare the size and distance between objects in the solar system.

d. Describe the characteristics of comets, asteroids, and meteors.

e. Research and report on the use of manmade satellites orbiting Earth and various planets.

Objective 2: Describe the use of technology to observe objects in the solar system and relate this to science's understanding of the solar system.

a. Describe the use of instruments to observe and explore the moon and planets.

b. Describe the role of computers in understanding the solar system (e.g., collecting and interpreting data from observations, predicting motion of objects, operating space probes).

c. Relate science's understanding of the solar system to the technology used to investigate it.

Objective 3: Describe the forces that keep objects in orbit in the solar system.

a. Describe the forces holding Earth in orbit around the Sun, and the moon in orbit around Earth.

b. Relate a celestial object's mass to its gravitational force on other objects.

c. Identify the role gravity plays in the structure of the solar system.

Standard IV: Students will understand the scale of size, distance between objects, movement, and apparent motion (due to Earth's rotation) of objects in the universe and how cultures have understood, related to and used these objects in the night sky.

Objective 1: Compare the size and distance of objects within systems in the universe.

a. Use the speed of light as a measuring standard to describe the relative distances to objects in the universe (e.g., 4.4 light years to star Alpha Centauri; 0.00002 light years to the Sun).

b. Compare distances between objects in the solar system.

c. Compare the size of the Solar System to the size of the Milky Way galaxy.

d. Compare the size of the Milky Way galaxy to the size of the known universe.

Objective 2: Describe the appearance and apparent motion of groups of stars in the night sky relative to Earth and how various cultures have understood and used them.

a. Locate and identify stars that are grouped in patterns in the night sky.

b. Identify ways people have historically grouped stars in the night sky.

c. Recognize that stars in a constellation are not all the same distance from Earth.

Standard IV:
Students will understand the scale of size, distance between objects, movement, and apparent motion (due to Earth's rotation) of objects in the universe and how cultures have understood, related to and used these objects in the night sky.

d. Relate the seasonal change in the appearance of the night sky to Earth's position.

e. Describe ways that familiar groups of stars may be used for navigation and calendars.

Science language students should use:
asteroids, celestial object, comets, galaxy, planets, satellites, star, distance, force, gravity, gravitational force, mass, scale, solar system, constellation, Milky Way galaxy, speed of light, telescope, universe, Sun, light years

Science Benchmark

Microorganisms are those living things that are visible as individual organisms only with the aid of magnification. Microorganisms are components of every ecosystem on Earth. Microorganisms range in complexity from single to multicellular organisms. Most microorganisms do not cause disease and many are beneficial. Microorganisms require food, water, air, ways to dispose of waste, and an environment in which they can live. Investigation of microorganisms is accomplished by observing organisms using direct observation with the aid of magnification, observation of colonies of these organisms and their waste, and observation of microorganisms' effects on an environment and other organisms.

Standard V: Students will understand that microorganisms range from simple to complex, are found almost everywhere, and are both helpful and harmful.

Objective 1: Observe and summarize information about microorganisms.

a. Examine and illustrate size, shape, and structure of organisms found in an environment such as pond water.

b. Compare characteristics common in observed organisms (e.g., color, movement, appendages, shape) and infer their function (e.g., green color found in organisms that are producers, appendages help movement).

c. Research and report on a microorganism's requirements (i.e., food, water, air, waste disposal, temperature of environment, reproduction).

Objective 2: Demonstrate the skills needed to plan and conduct an experiment to determine a microorganism's requirements in a specific environment.

a. Formulate a question about microorganisms that can be answered with a student experiment.

b. Develop a hypothesis for a question about microorganisms based on observations and prior knowledge.

c. Plan and carry out an investigation on microorganisms. {Note: Teacher must examine plans and procedures to assure the safety of students; for additional information,

Standard V:
Students will understand that microorganisms range from simple to complex, are found almost everywhere, and are both helpful and harmful.

you may wish to read microbe safety information on Utah Science Home Page.}

d. Display results in an appropriate format (e.g., graphs, tables, diagrams).

e. Prepare a written summary or conclusion to describe the results in terms of the hypothesis for the investigation on microorganisms.

Objective 3: Identify positive and negative effects of microorganisms and how science has developed positive uses for some microorganisms and overcome the negative effects of others.

a. Describe in writing how microorganisms serve as decomposers in the environment.

b. Identify how microorganisms are used as food or in the production of food (e.g., yeast helps bread rise, fungi flavor cheese, algae are used in ice cream, bacteria are used to make cheese and yogurt).

c. Identify helpful uses of microorganisms (e.g., clean up oil spills, purify water, digest food in digestive tract, antibiotics) and the role of science in the development of understanding that led to positive uses (i.e., Pasteur established the existence, growth, and control of bacteria; Fleming isolated and developed penicillin).

d. Relate several diseases caused by microorganisms to the organism causing the disease (e.g., athlete's foot -fungi, streptococcus throat -bacteria, giardia -protozoa).

e. Observe and report on microorganisms' harmful effects on food (e.g., causes fruits and vegetables to rot, destroys food bearing plants, makes milk sour).

Science language students should use:
algae, fungi, microorganism, decomposer, single–celled, organism, bacteria, protozoan, producer, hypothesis, experiment, investigation, variable, control, culture

Science Benchmark

Heat, light, and sound are all forms of energy. Heat can be transferred by radiation, conduction and convection. Visible light can be produced, reflected, refracted, and separated into light of various colors. Sound is created by vibration and cannot travel through a vacuum. Pitch is determined by the vibration rate of the sound source.

Standard VI: Students will understand properties and behavior of heat, light, and sound.

Objective 1: Investigate the movement of heat between objects by conduction, convection, and radiation.

a. Compare materials that conduct heat to materials that insulate the transfer of heat energy.
b. Describe the movement of heat from warmer objects to cooler objects by conduction and convection.
c. Describe the movement of heat across space from the Sun to Earth by radiation.
d. Observe and describe, with the use of models, heat energy being transferred through a fluid medium (liquid and/or gas) by convection currents.
e. Design and conduct an investigation on the movement of heat energy.

Objective 2: Describe how light can be produced, reflected, refracted, and separated into visible light of various colors.

a. Compare light from various sources (e.g., intensity, direction, color).
b. Compare the reflection of light from various surfaces (e.g., loss of light, angle of reflection, reflected color).
c. Investigate and describe the refraction of light passing through various materials (e.g., prisms, water).
d. Predict and test the behavior of light interacting with various fluids (e.g., light transmission through fluids, refraction of light).
e. Predict and test the appearance of various materials when light of different colors is shone on the material.

Standard VI:
Students will understand properties and behavior of heat, light, and sound.

Objective 3: Describe the production of sound in terms of vibration of objects that create vibrations in other materials.

a. Describe how sound is made from vibration and moves in all directions from the source in waves.

b. Explain the relationship of the size and shape of a vibrating object to the pitch of the sound produced.

c. Relate the volume of a sound to the amount of energy used to create the vibration of the object producing the sound.

d. Make a musical instrument and report on how it produces sound.

Science language students should use:
angle of incidence, angle of reflection, absorption, conduction, conductor, convection, medium, pitch, prism, radiation, reflection, refraction, spectrum, vibration

Facilitated

Activities

What MI am I? Questions

Verbal Linguistic • I like to read a lot. • I enjoy crosswords and other word games. • I am good at written tests and essays. • I can remember things exactly as they are told to me. • I frequently quote things from books I've read or movies I've seen. • I am a good story teller and/or writer. • I like to talk through problems and explain solutions.	**Bodily Kinesthetic** • I like thrilling rides. • I use my hands and body language when I talk. • I like to learn something by doing it rather than reading about it or watching a video. • I like crafts and hobbies where I get to use my hands. • I don't like to sit too long and/or I move, tap or fidget while sitting. • I always touch things and examine the tex-
Logical Mathematical • I enjoy math and/or science. • I like working with numbers and can do mental calculations. • I like logical thinking puzzles, brainteasers, and strategy games. • I like to categorize and group things. • I am interested in new scientific advances. • I create lists (to do lists, itineraries, etc.). • I easily grasp cause and effect relationships.	**Naturalist** • I am involved in protecting the environment. • I prefer to be outdoors. • I like gardening. • I enjoy fishing and/or tracking. • I have or like pets. • I can recognize and name many different trees, flowers, and plants. • I notice tracks, nests, and wildlife while walking or hiking and/or read weather signs.
Visual Spatial • I like to record events by taking pictures or video recordings. • I doodle when I am listening to people, taking notes, or thinking. • I can visualize how things look from different perspectives • I prefer reading material with illustrations. • I enjoy visual games and/or puzzles, mazes, etc. • I can easily ready charts and maps. • I remember things best by seeing them.	**Interpersonal** • I have many close personal friends. • I communicate well with people and people enjoy talking with me. • I prefer team sports. • I can tell what others are feeling. • I like to share my ideas and feelings with others. • I work best in cooperative groups. • I like to get the advice of others to help me solve a problem or make a decision.
Musical Rhythmic • It is easy for me to follow the beat of music and keep time. • I enjoy engaging in musical activities. • I can play an instrument and/or sing on key. • I can usually remember a tune after hearing it a couple of times. • I like to listen to music at home or riding in the car. • Theme music and commercial jingles often pop into my head. • I like to listen to music while I work.	**Intrapersonal** • I have a few close friends. • I am not easily influenced by other people (peer pressure). • I know about my own feelings, strengths, and weaknesses. • I enjoy being alone sometimes and am happy with my own company. • I prefer to work alone. • I like to make up my own mind and am an independent thinker. • I keep a personal diary or log.

What MI am I? Graph

verbal/ linguistic	logical/ mathematical	visual spatial	musical/ rhythmic	bodily kinesthetic	naturalist	inter personal	intrapersonal

Café Chez Journal

Math Menu

Desserts

Wonderings

Lesson feedback

Lateral thinking prompts
(e.g., If math was an animal, what animal would it be and why?)

Reflections on tests

Mathematics on tests

Book reports

Hors d' Oeuvres

About the author

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Copy of the COREs

CRT reference sheets

Affective interest inventory

Multiple intelligence graph

Goal setting

Main Entrees

Math Entrees

Explaining a process

Defining terms

Prove and disprove statements

Creating their own problems

Graphic organizers
(Venn diagrams, mind maps, graphs, tables, foldables, etc.)

Café Chez Journal

Science Menu

Desserts

Wonderings

Unanswered questions

Student explorations

Discovery days

Science process skills

Hors d' Oeuvres

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Glossary

Bell ringers

Self starters

Sticky notes or tabs

Main Entrees

Science Entrees

Experiments: Question, Prediction, Planning, Observations, Claims, Wonderings

Quick writes: What have I learned today?

Reflections

Graphic organizers

Observations

Lecture notes

Oh No! 9.9 Directions

- This is a game that you play with a partner.
- Each team gets one set of cards. Show them the overhead of the cards in the deck. Inform them that there is two of each card in the deck.
- Each player gets 4 cards to start and will always have 4 cards in his/her hand.
- The rest of the cards are placed face down in a “draw pile”.
- The player with the birthday closest to January 1st starts.
- He/she lays down one card to start the game then draws another from the draw pile.
- Player 2 places a card from his/her hand on top and finds the sum of the two cards then draws from the draw pile.
- Play continues back and forth keeping a running a total.
- The object of the game is to force your opponent to lay down a card that puts the total over 9.9. (9.9 is fine 9.91 is not).
- The player who goes over 9.9 looses the game.

Oh No! 9.9 Possible Journal Prompts

“What are all the mathematical expressions you can think of that give you the answer 9.9?”

“What is your strategy for winning this game?”

“What cards are more helpful at the beginning of the game and why?”

“What cards are more helpful at the end of the game and why?”

“What do you think is the best card in the deck?”

“What would be the 4 best cards to have in your hand at the end of the game?”

Oh No! 9.9 Game Cards

add .1	add .1	add .2	add .2
add .25	add .25	add .3	add .3
add .4	add .4	add .5	add .5
add .6	add .6	add .7	add .7

add .8	add .8	add .9	add .9
add 1	add 1	add 1/2	add 1/2
add 1/4	add 1/4	add 3/4	add 3/4
add 1/5	add 1/5	add 2/5	add 2/5

add 3/5	**add 3/5**	**add 4/5**	**add 4/5**
add 1/10	**add 1/10**	**add 3/10**	**add 3/10**
add 7/10	**add 7/10**	**add 9/10**	**add 9/10**
add 1 1/2	**add 1 1/2**	**add 1.5**	**add 1.5**

subtract .5	**subtract .5**	**subtract 1/2**	**subtract 1/2**
subtract .1	**subtract .1**	**subtract 1/10**	**subtract 1/10**
subtract .75	**subtract .75**	**subtract 3/4**	**subtract 3/4**
subtract 1	**subtract 1**	**subtract 1**	**subtract 1**

Ordering Objects in the Universe Cards

Width of a DNA Helix	Length of an Average Virus	Length of an average bacteria
Width of a human hair	Radius of the head of a pin	One inch
One foot	Height of an "average" human	Basketball court
Football field	Distance sound travels in 1 second	One mile
Mount Everest	Altitude of the Hubble Space Telescope	Radius of the Moon
Radius of Earth	Radius of Jupiter	Radius of the Moon's orbit
Radius of the Sun	Earth's orbital radius	Pluto's orbital radius
Milky Way Galaxy - from center to edge	Distance to Alpha Centuri	Radius of Observable Universe

Spacing Out in Space Directions

Directions:

1. Provide sentence strips.
2. Fold the strip in half and open up.
3. Label the sun, Pluto, Uranus, and Neptune.
4. Fold sun to Uranus. Write Saturn on the crease.
5. Fold sun to Saturn. Write Jupiter on the crease.
6. Fold sun to Jupiter. Write asteroid belt on the crease.
7. Fold sun to asteroid belt. Write Mars on the crease.
8. Fold sun to Mars. Write Venus on the crease.
9. Discuss what would be found in between the sun and Venus. Write in Mercury.
10. Discuss which planet is missing. Write in "Earth" in between "Venus" and "Mars".

AGE

	Object	Age
1.	Hubble Telescope	a few years (1990)
2.	Moon	approx. 4.5 billion years
3.	Jupiter	approx. 4.5 billion years
4.	Sun	approx. 4.5 billion years
5.	Alpha Centauri	approx 10 billion years
6.	Galaxy	approx 10 billion years

SIZE

	Object	Size in Miles	Kilometers
1.	Hubble Telescope	40 feet long	12 meters
2.	Moon	2,000 miles diameter	3,200 kilometers
3.	Jupiter	88,736 miles diameter	142,984 kilometers
4.	Sun	875,000 miles diameter	1,408,000 km
5.	Alpha Centauri	20,000,000 miles diameter	32,000,000 km
6.	Galaxy	600 thousand trillion miles	1 X 1018 km

DISTANCE

	Object	Miles	Kilometers
1.	Telescope surface of the Earth	350 miles above the	560 km
2.	Moon	250,000 miles	402,000 km
3.	Sun	93,000,000 miles	1.5 X 108 km
4.	Jupiter	790 million mile (closest)	1.3 X 109 km
5.	Alpha Centauri	4.37 light-years distant 25.8 trillion miles	41.5 trillion km
6.	Galaxy	200 million trillion miles	3 X 1020 km

Order Me by AGE, SIZE, and DISTANCE

1. Order the objects in space by their age from youngest to oldest.

2. Order the objects in space by their size from smallest through largest.

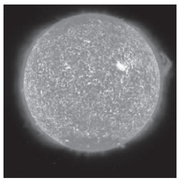
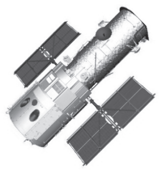
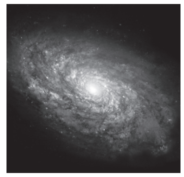
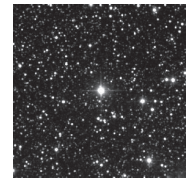
3. Order the objects in space by how close they are to the Planet Earth (nearest to farthest.)

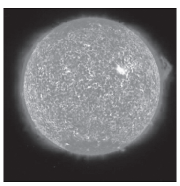
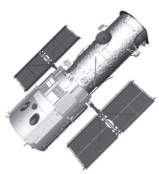
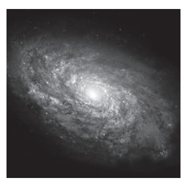
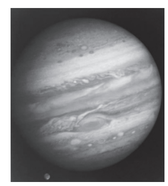
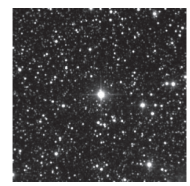
Record three interesting findings:

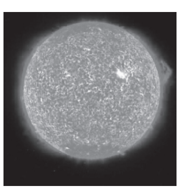
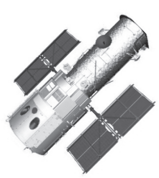
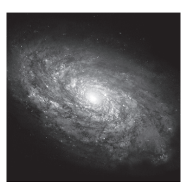
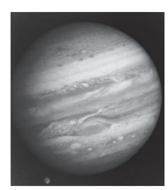
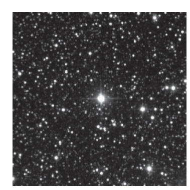
1.

2.

3.

					
Sun	Hubble Space Telescope	Galaxy	Moon	Jupiter	Alpha Centarui

					
Sun	Hubble Space Telescope	Galaxy	Moon	Jupiter	Alpha Centarui

					
Sun	Hubble Space Telescope	Galaxy	Moon	Jupiter	Alpha Centarui

Name ______________________________

Interest Grouping

Please rate these on a scale of 1 - 6, with 1 being your most favorite and 6 being your least favorite.

[ ] Write

[ ] Draw

[ ] Act (Drama)

[ ] Build

[ ] Research

[ ] Music/Singing

Name ______________________________

Interest Grouping

Please rate these on a scale of 1 - 6, with 1 being your most favorite and 6 being your least favorite.

[ ] Write

[ ] Draw

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[ ] Build

[ ] Research

[ ] Music/Singing

Name ______________________________

Interest Grouping

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Name ______________________________

Interest Grouping

Please rate these on a scale of 1 - 6, with 1 being your most favorite and 6 being your least favorite.

[ ] Write

[ ] Draw

[ ] Act (Drama)

[ ] Build

[ ] Research

[ ] Music/Singing

Tic-Tac-Toe Menu Astronomy

You should select any three of the following activities to complete your Astronomy Project.

Due Dates: 1st activity:
2nd activity:
3rd activity:

Venn Diagram Create a Venn Diagram in a creative shape comparing one object in space to another. Choose from: planets, comets, asteroids, meteoroids, constellations, or satellites.	**News Article** Write a newspaper article detailing a significant event in astronomy. Be sure to include the 5 W's: who, what, where, when, and why. You may also write a news brief about an upcoming event.	**Acrostic poem** Create an acrostic poem or phrases and sentences about one of the planets. Your phrases should apply specifically to your planet, not just planets in general.
Letter Write a one-page letter to the President explaining the benefits of continuing the funding for space exploration. Include at least five "Space Spinoffs" used today from the space program (for example: velcro).	**Free Space** You create a fun activity about your subject. Remember to have it approved by your teacher before you begin.	**Space Glossary** Create a glossary of at least 10 astronomical terms. Define each term and provide an example of how that object is used/found in space.
Diary Entries Write seven diary entries that might have been written by an astronaut or someone working in the space program.	**Conflict Paper** Should Pluto have been demoted to the status of a Dwarf Planet, or remained classified as a planet? Write a 5-paragraph essay stating your opinion of this.	**Scrapbook Pages** Create two scrapbook pages of a space launch. Include the purpose of the launch, people involved, and time line of the launch. (jpl website)

Tic-Tac-Toe Rubric

Type of Activity	A Grade	B Grade	C Grade
Venn Diagram			Venn Diagram Drawn 3 similarities, 3 differences, and 3 things in common
News Article			News article, at least 2 paragraphs, and includes 5 Ws
Acrostic Poem			One word per letter of a planet
Letter			Written in letter format, includes 2 ways we use Space Spinoffs
Space Glossary			Includes at least 7 technology terms and definitions
Diary Entries			Includes 5 diary entries of at least 3 sentences each.
Conflict			Includes a thesis statement and 2 - 3 paragraphs why Pluto should be a planet.
Scrapbook Pages			Two scrapbook pages that include 1 of the 3 requirements

NIM Instructions

Learning Objectives:
We will:

- Identify, extend and use patterns to play the game.
- Learn skills and strategies to win the game
- Identify math found in the game

Language Objective:
Explain to your partner the methods you use to find winning strategy.
Using NIM as Differentiated
Problem Solving Approach Problem

NIM

- **Take 10-15 counters from your bag.**
- **Lay them out in a line**
- **With a partner, take turns picking 1, 2, or 3 pieces**
- **No skipping turns!**
- **The winner takes the last 1, 2, or 3 pieces.**
- **Test for winning strategies**

Thoughtful Questions

- **Is it better to go first or second?**
- **When do you know that you are going to win for sure? What does the board look like?**
- **Think about your move, and try to figure out what your opponent is going to do?**
- **Which moves are poor moves?**
- **Would your strategy change if there were a different amount of counters?**
- **Would your strategy change if the maximum number of counters taken per move were changed?**
- **Have you tried testing some of your theories?**
- **Would it be easier if you worked backward or made the game smaller?**

拳術 NIM 秋天

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Instructions for Play:

____

____

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You cannot

____

Winning Strategies:

____

____

____

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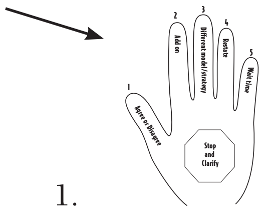
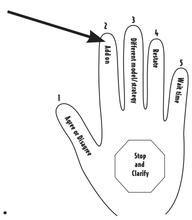
Examining The Five Fingered Math Talk Strategies

1. 

Asking students to apply their own reasoning to someone else's reasoning:

Examples:

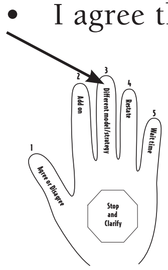
- Do you agree or disagree and why?
- Can you tell us why you agree with what ___________________just said?
- Would you all discuss what _____________________ just said? (Wait)

2. 

Prompting students for further participation:

Examples:

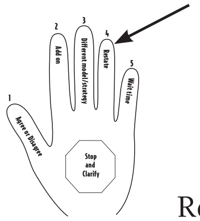
- Would anyone like to add to the discussion?
- Turn and talk to your partner about _______________________.
- I agree that ________________, but why is that important?

3. 

Promoting the sharing of different strategies and methods:

Examples:

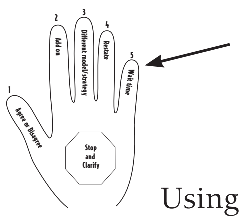
- Who thinks they can explain why _____________ did ________________? Talk to the person next to you for a moment about this.
- Let's try ____________'s method/procedure for ________________. Work with the person next to you. (Wait) Okay, now that you've had a chance to try _________'s procedure, who would like to explain to us what you did?
- How is your strategy (method) different from_______________'s ? What is similar about ______________'s and ______________'s strategies?
- So ______________solved it by___________________. Who solved it a different way?"

4. 

Restating: Asking students to restate what another student has said.

Examples:

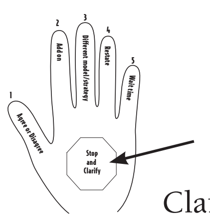
- Can anyone repeat what ______________just said in his or her own words?
- That is an important question. Can anyone repeat what ________________just said?
- Can someone repeat what ___________________ did for his solution so far?”

5. 

Using wait time:

Examples:

- Take your time, we’ll wait.
- Okay, let’s pause for a minute.
- Okay, let’s back up and go over what we’ve talked about so far.

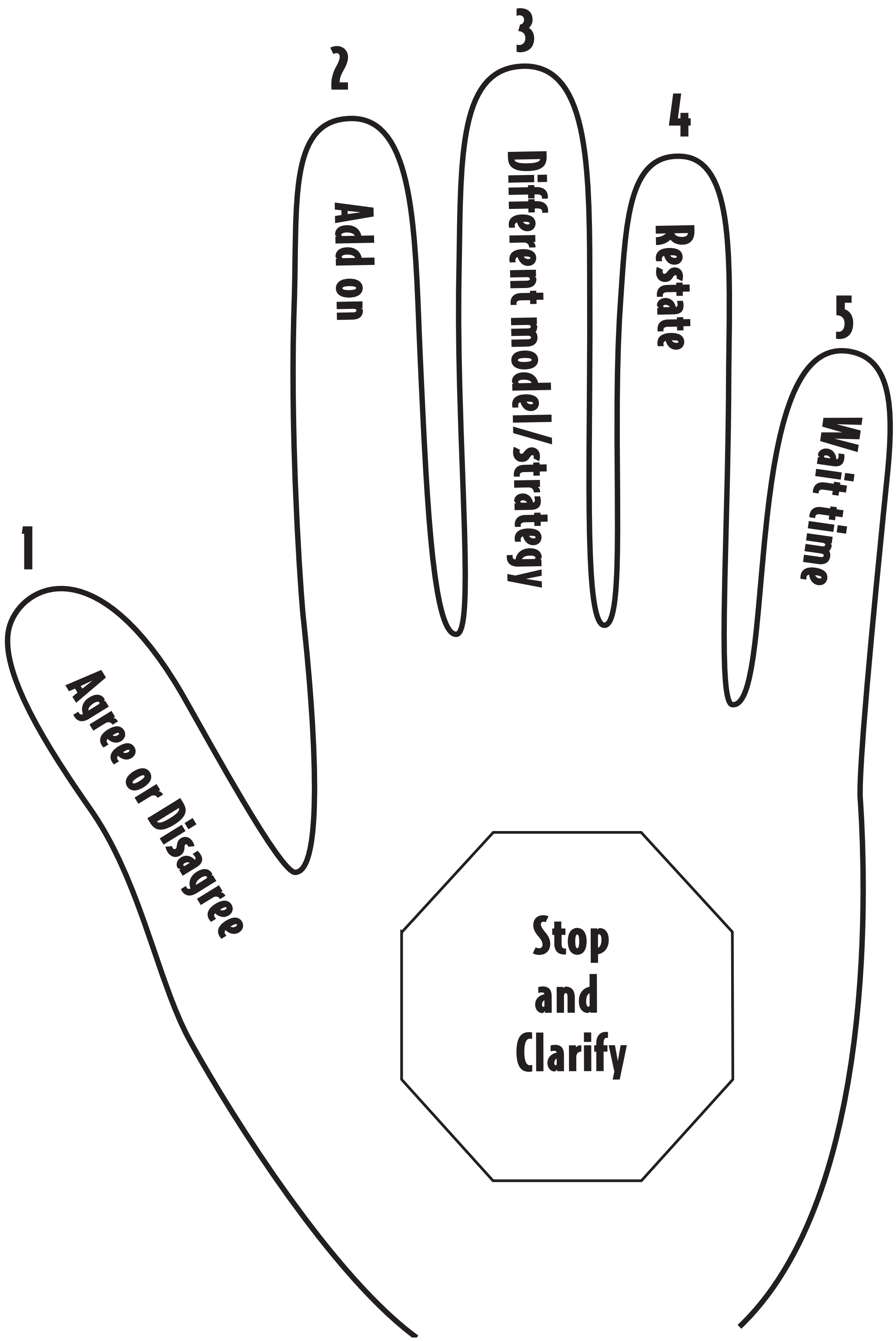
6. 

Clarifying and checking for Understanding

Examples:

- ___________, can you tell more about _____________________?”
- I agree that ________________, but why is that important?
- ______________, could you be a little more specific?”

Examining The Five Fingered Math Talk Strategies



Guide For Mathematical Discussions

THREE FORMATS: Each has value and should be a part of EVERY lesson EVERYDAY.		
Many Heads	**3 to 4 Heads**	**2 Heads**
GRAPHIC to match heading	GRAPHIC to match heading	GRAPHIC to match heading
1. Whole Class Discussion: Provides an opportunity for students to share their thinking, explain their steps and their reasoning, and build on one another's contributions. Teachers **focus on student thinking**, not providing answers.	**2. Small Group Discussion:** Students are given a task to discuss among themselves in groups of three or four. Teacher circulates as groups discuss without controlling the discussion but interjecting questions to keep students ideas moving forward.	**3. Partner Talk:** Teacher asks the question and gives students a minute or two at the most to put their thoughts into words with their partner. Students who understand but are hesitant about voicing their thoughts will have a chance to practice in a small safe environment. Students who have not understood can bring up questions with the partner. **For many students, particularly those who are learning English as a second language, this one- or two-minute aside is invaluable.**

Multiple Intelligences/Learning Styles

Children think, learn and create in a myriad of different ways. Howard Gardner's model of multiple intelligences recognizes the broad range of talents and learning styles we find in our students. Within his model, Gardner identified and categorized eight different intelligences: verbal/linguistic, logical/mathematical, bodily/kinesthetic, intrapersonal, interpersonal, musical/rhythmic, visual/spatial, and naturalistic. According to Gardner, every child possesses each of these intelligences, but some are developed more than others, depending on the individual. Teachers can take these categories and differentiate curriculum through the preparation of activities that nurture these intelligences in students. Indeed, the development of each child's potential is directly influenced by how effectively teachers match what students learn with how they learn (their own particular intelligences).

It is recommended that teachers use the eight multiple intelligences as a springboard to create activities that challenge students to take control of their own learning. Making students aware of the different intelligences will help them identify how they learn best and also which methods challenge them. Teachers can target activities that lead students to enhance both their strengths and weaknesses.

Indeed, educators can think of multiple intelligences as a philosophy of how children learn. University of California—Riverside's Sue Teele describes the goal of Gardner's model in this way: "Multiple intelligences provide for different windows into the same room. We need to unleash the creative potential in all our schools in order to open as many windows as possible for every student in every classroom to succeed . . .the future mandates that we all move forward together in a way that builds on both our mutual strengths and respects our unique differences."

Teele's research suggests that certain intelligences are stronger in students, depending on their stages of development. Using a survey she developed, (the "*Teele Inventory for Multiple Intelligences*"), Sue studied the learning preferences of more than 6,000 students. Her findings revealed that the verbal/linguistic intelligence is strongest in students in kindergarten through third grade. First through fourth grade students show a definite preference for the logical/mathematical intelligence. The visual/spatial and bodily/kinesthetic intelligences are dominant throughout both elementary and middle school. Middle school students also show a preference for the musical/rhythmic and interpersonal intelligences. Based on Teele's findings, elementary school teachers would be well advised to plan lessons that incorporate the use of verbal/linguistic, logical/mathematical, visual/spatial and bodily/kinesthetic activities.

Here are a few considerations for educators, as they strive to create activities based on the different learning styles of their students:

- *Change it up.* Educators should choose activities that target varied intelligences. Since teachers tend to plan lessons and activities that fit their own learning preferences, it's important for them to self-assess and to be sure that all of the intelligences are being represented.

- *Be clear.* When differentiating the "product," teachers need to be sure that students have clear directions (task cards, or posted instructions). Also, routines/procedures should be established for students so they know how/where to find materials and who/when to ask for help.
- *Be realistic.* It's not necessary or appropriate for teachers to use all eight intelligences in every lesson. During the planning phase, the Core Curriculum and unique needs of the students should be considered to determine which two or three to incorporate.
- *Remember to reflect.* Best practice suggests that after trying something new, professionals take time to reflect, including notes of what to retain and what to refine.
- *All in good time.* It can be overwhelming for teachers to create activities that incorporate the multiple intelligences in every single lesson for every content area. Common sense suggests to start with "baby steps" and consult with colleagues for ideas throughout the process.
- *Communicate with parents.* Both students and their parents will appreciate the insights that come from recognizing and putting a name to their unique learning styles. In fact, teachers can invite parents to help students identify their preferences by sending home a *Learning Preferences Survey* to be completed by students and parents together (each horizontal row represents a learning style/intelligence).

References

Tomlinson, C.A. (1999). *The Differentiated Classroom.* (p. 83). Alexandria, VA: ASCD.

Conklin, W. (2007). *Applying Differentiation Strategies*. (pp. 149-202). Huntington Beach, CA: Shell Education.

Teele, S. (1994). Redesigning the educational system to enable all students to succeed. Doctoral dissertation, University of California—Riverside.

Resources

http://www.thomasarmstrong.com/multiple_intelligences.htm

http://en.wikipedia.org/wiki/Multiple_Intelligences

Gardner's Eight Multiple Intelligences

Intelligence	Student Likes	Student Needs
Verbal/Linguistic "word smart" The student thinks in words.	Words: writing, reading, playing word games, telling interesting stories	journals, books, writing materials
Logical/Mathematical "number/reasoning smart" The student thinks by reasoning.	Numbers or logic: figuring out problems, puzzles, experimenting, calculating	Science supplies, trips to museums, math manipulatives
Visual/Spatial "picture smart" The student thinks in pictures.	Pictures: draw, design, doodle	art supplies, building materials, video equipment, puzzles
Bodily/Kinesthetic "body smart" The student thinks by using his/her body.	A physical experience: dancing, moving, jumping, running, touching	movement, sports, theater, physical games, hands-on activities
Rhythmic/Musical "music smart" The student thinks in melodies and rhythms.	Music: listening to music, making own music, tapping to the rhythm, singing	play musical instruments, see concerts, use a karaoke machine
Interpersonal "people smart" The student thinks by talking about his/her ideas to others.	A social experience: organizing events, being the leader, partying, mediating between friends	time with friends, group projects, social events
Intrapersonal "self-smart" The student keeps his/her thoughts to him/herself.	Self-reflection: setting goals, mediating, daydreaming, quiet places	time alone, individualized projects
Naturalist "nature smart" The student thinks by classifying.	An experience in the natural world: studying anything in nature including rocks, animals, plants, and the weather	time outside, nature hikes, telescopes, binoculars, notebooks for classification

Tiered Activities

Using tiered lessons is a way for teachers to ensure that all students, regardless of ability level or learning style, progress towards mastery of learning goals and objectives. Tiered assignments, also known as scaffolding, allow for differing levels of readiness and performance levels. The entire class works toward the same essential understanding (parallel tasks) but their paths to that goal depend upon their abilities and learning styles (varied levels of depth and varied degrees of support).

The following are guidelines for planning tiered lessons/assessments. Teachers should:

1. Using the Core Curriculum, pick a concept or skill that needs to be learned (e.g. "What's the ultimate measurable objective?").
2. Think of an activity that matches the objective.
3. Use pre-assessment data to determine the individual needs of the students. Consider students performing above grade level, students below grade level, English Language Learners, and students with varying learning style preferences (multiple intelligences).
4. Take another look at the selected activity. Target its complexity to be appropriate for on-grade-level learners.
5. Modify the activity or assessment to meet the needs of the other learners in the class. Within one activity, there will be several tiers to meet the wide range of student needs.
6. Seek consultation from the specialists in the school, as well as fellow colleagues.
7. Teach the activity, including the various tiers.
8. Reflect and refine.

Remember, tiered lessons provide differentiation because of varied levels of complexity, not necessarily because of varied quantities of work. Here are a few considerations for educators, as they implement use of tiered activities to scaffold for student learning:

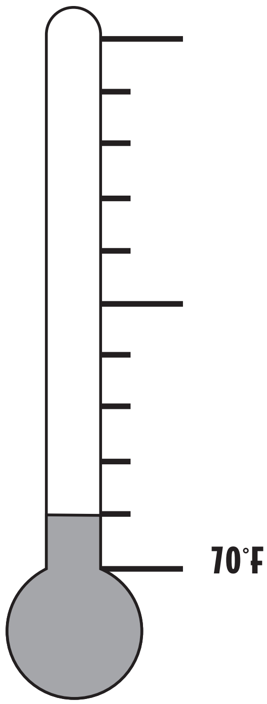
- Just because students are above grade level, that does not mean they should be given more work.
- Just because students are below grade level, that does not mean they should be given less work.
- All tiered activities should be interesting and appealing.
- All tasks should provide a challenge.

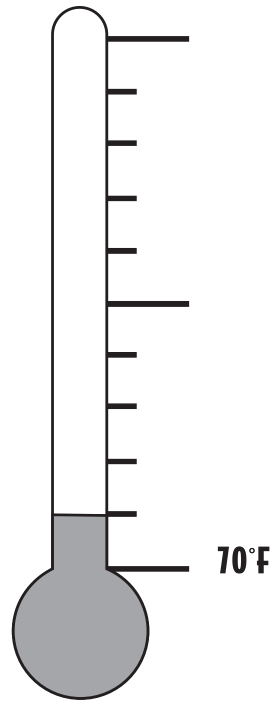
Tomlinson, C.A. (1999). *The Differentiated Classroom*. (p. 83). Alexandria, VA: ASCD.

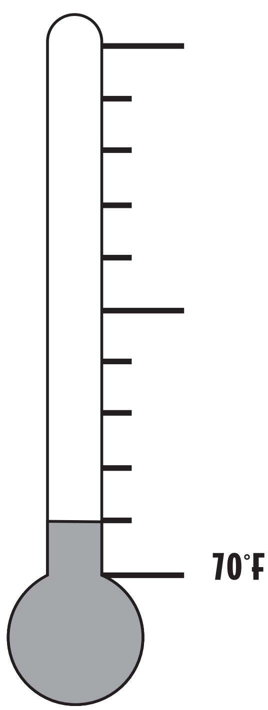
Conklin, W. (2007). *Applying Differentiation Strategies*. (pp. 149-202). Huntington Beach, CA: Shell Education.

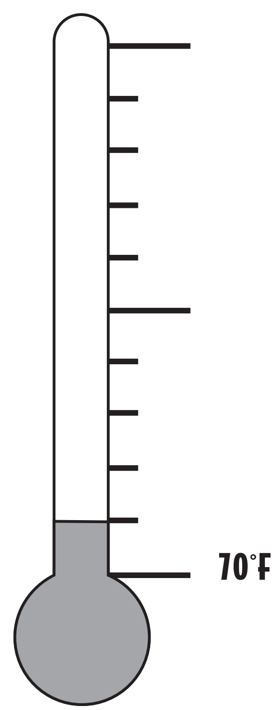
McCombs, B.L. (1995). Understanding the keys to motivation to learn. *Noteworthy Perspectives: What's Noteworthy on Learners, Learning, and Schooling.*

Thermometer









Science II-2

Activities

Earth's Tilt

Catching Some Rays

Standard II:

Students will understand how Earth's tilt on its axis changes the length of daylight and creates the seasons.

Objective 2:

Explain how the relationship between the tilt of Earth's axis and its yearly orbit around the sun produces the seasons.

Intended Learning Outcomes:

1. Use Science Process and Thinking Skills
2. Manifest Scientific Attitudes and Interests
3. Communicate Effectively Using Science Language and Reasoning

Content Connections:

Language Arts VII: Understand, interpret, and analyze narrative and informational
Math III: Geometric shapes and principles
Math V: Basic concepts of probability

Science Standard II

Objective 2

Connections

Background Information

There are many misconceptions about what causes seasons. When people think about Earth's revolution around the sun, many picture a very oval, elliptical shape. Earth's orbit is a slightly elliptical circle. However, the distance between the sun and Earth does not change significantly throughout the year.

Because of Earth's tilt and revolution around the sun, each of Earth's poles tilt toward the sun for part of the year. Consequently, each pole is tilted away from the sun for part of the year. When the Northern Hemisphere is tilted towards the sun, the result is more hours of daylight and more direct, intensified sunlight for our hemisphere. Direct light causes higher temperatures than indirect light. When our hemisphere is tilted away from the sun during winter, the angled sunlight is spread over a greater area, resulting in less intense heat.

Research Basis

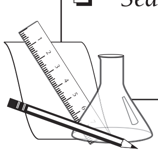
McCoy, J. D., & Ketterlin-Geller, R., (2004). Rethinking instructional delivery for diverse student populations: Serving all learners with concept-based instruction. Intervention in School & Clinic, 40.2, pp. 88-95.

Science issues are a part of our everyday world, but what commonly happens with the teaching of science is students are smothered in abstract and highly theoretical science content. Teachers need to focus on teaching the big essential ideas and concepts, rather than teaching minute details and memorizing facts to regurgitate on a test.

One method of doing this is by using hands-on activities that are modeled after real life situations. This helps students focus on concrete applicable science that is interesting and relevant. Another method is simple, inexpensive labs and activities that require little specialized equipment, but focus on key models or experiments that illuminate specific scientific content. This gives students access to the curriculum in a meaningful way.

Materials

- ❏ *Reader's Theater of Demeter and Persephone*
- ❏ Index cards
- ❏ *Seasons Brainstorming Chart*
- ❏ Styrofoam board
- ❏ Skewers
- ❏ Art paper
- ❏ Scissors
- ❏ Glue
- ❏ Tape
- ❏ Thermometers
- ❏ Protractor
- ❏ Timer
- ❏ *Sunray Data Collection Sheet*
- ❏ Colored pencils
- ❏ *Sunray Line Graph*
- ❏ *Sunray Bar Graph*
- ❏ *Centimeter Grid Paper*
- ❏ Flashlight
- ❏ Science journal
- ❏ *Seasons: The Reasons*



Invitation to Learn

1. The ancient civilization of Greece explained the seasons in a very different way than modern scientists do today. First students will participate in a reader's theater in which the Greek gods tell the story of Demeter and her beautiful daughter, Persephone. The myth tells of the dark god, Hades, kidnapping Persephone and taking her to the underworld to live as his wife. When Demeter hears of her daughter's fate, she mourns so violently that Earth begins to whither and die. It is only upon Persephone's return that Earth blooms to life again. Tell students to pay close attention to how the Ancient Greeks explained the reasons for seasons while reading the myth.
2. Tell students that scientists today explain the reason for Earth's seasons in a very different way than the Ancient Greeks did. Provide each student with an index card. Ask students to write what they know (or think they know) about the scientific explanation for seasons on their card. Collect cards and post them on a board that compares accurate scientific information with misconceptions. Students should compare and contrast the Ancient Greek ideas, common modern-day misconceptions, and the real reasons for seasons throughout the unit. Concepts should be reviewed and updated as knowledge grows, changes, and clarifies.

Instructional Procedures

Activity One: Activating Background Knowledge

1. As a quick, cooperative learning activity, activate students' prior knowledge on the concept of seasons, temperature, and seasonal connections to the students' world. Students should work in small groups to complete the following Seasons Brainstorming Chart: (Charts should be cut out and placed into science journals.)

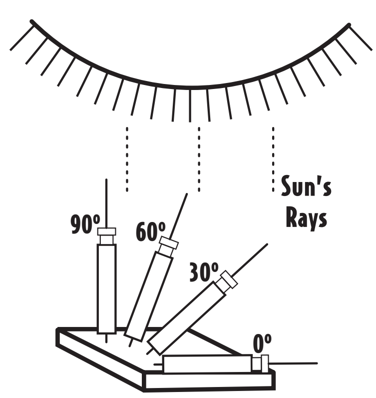
Seasons	Average Temperature	Signs in Nature	People's Activities
Winter			
Spring			
Fall			
Summer			

Activity Two: Sunray Catchers

1. Explain to students that they will be gathering information to explain the real reasons for seasons by collecting detailed temperature data. (This activity should be done outside on a day with little cloud cover to see the most dramatic results.)
2. Allow a short amount of time for students to practice reading the thermometers, holding steadily at eye level and not obstructing the bulb with their fingers. Have students examine the scale used on the thermometers. Ask each group of students to stand in a different area of your classroom and report the accurate temperature. Just as the temperatures within your classroom will differ slightly because of exposure to heat sources and movement, so does the temperature on Earth. In order for students to see accurate results, first calibrate all the thermometers by placing them in ice water for 5 minutes. Students will be able to see the thermometer rise significantly when they move the thermometer to their specified location.

Construction of Sunray Tool

1. Explain to the students that they are going to construct a sunray-gathering tool to help model one reason for the seasons. Construct the sunray-gathering tool with students in groups of three or four.
2. Begin by cutting a piece of Styrofoam about 12 inches square for each group. (This board will be reused in a subsequent lesson.)
3. Now, groups are going to construct holders for the 4 thermometers. Each group will be



given a 12" x 18" piece of art paper that has previously been cut in half lengthwise so that it measures 6" x 18". Have students fold their paper in half, and in half again, creating four equal sections that are 4½" x 6". Cut pieces apart. Then, students should fold each piece in half and glue the outer edges, creating a pocket to hold a thermometer. Finally, have the students label the pockets: 0 degrees, 30 degrees, 60 degrees, and 90 degrees.

4. Tape a skewer to the back of each pocket. The top of the skewer should line up with the top of the pocket.
5. Place a protractor on the horizontal edge of the Styrofoam. Measure with the protractor and push the 30, 60, and 90-degree skewers into the tag board at the correct angle. Slip a thermometer into each pocket, making sure each thermometer bulb is covered. Rest the fourth skewer (0 degrees) on the Styrofoam and use a small piece of tape to hold in place.

Experimenting with the Sunray Catchers

1. Have the students take their ray-catcher, science journal, *Sunray Data Collection Sheet*, four different colored pencils, and the *line graphing paper* outside and choose a location exposed to the sun. Each student group should choose a different location.
2. Students will wait 10 minutes. While students are waiting have them record the procedure for construction of the sunray catcher and their hypothesis for this ray-catching experiment in their science journal.
3. After 10 minutes, making sure to keep the bulb covered, students will slide the thermometer out of the holder enough to read it at eye level. Record the temperatures on the data collection chart. Wait and record the temperatures two more times. As students are waiting to read the thermometers at the stated intervals, they should create a four-line graph on the sunray line graphing paper demonstrating the data they are collecting. Use a separate color for each angle. Label the graph key. Students should record any trends or conclusions they observe in their science journals.
4. When students return to the classroom, have students use calculators to determine the average temperature for each thermometer. Have the students discuss their findings and observations in small groups and then with the whole group. Discuss the trend shown in the data collected. (The temperature increases as the directness of sunlight increases.)

5. Students will finalize findings by creating a bar graph of the averaged data on the sunray bar graphing paper.
6. Instruct students to journal in their science notebooks about today's experiment. What was the experiment? (How does the angle of the sun's rays affect temperature?) What was the variable in our experiment? (The angles of the thermometers.) Sketch a model of the experiment. Write a conclusion based on direct and indirect sunrays based upon today's experiment. (More direct light equals more heat; less direct light equals less heat.) What are the limitations of the model we used? (It is not done to scale; we only used four sun angles, etc.)

Activity Three: Putting a Spotlight on Seasons

1. Do a quick demonstration on the concept of direct and indirect rays by shining a flashlight with a bright, concentrated beam at your classroom globe. Hold the flashlight at a 90-degree angle and have students describe the shape of the light they see shining on the globe. How would students describe these light rays? (Direct light) Hold the flashlight at approximate 60 and 30-degree angles and have students notice how the shape of the light changes. How would students describe these light rays? (Indirect light) Ask students to infer: What would happen to the heat of the sun's rays if they were spread over a larger area? (The heat would be less intense as it spread out.)
2. Have students work in pairs or small groups to compare the area of direct and indirect light. First, students shine light from a flashlight directly onto the centimeter graph paper from 10 centimeters above the paper. One student holds the flashlight as the other student traces around the beam of light shining onto the paper. Students count the squares on the grid paper and estimate the area of the light ray. Then, using a protractor, tilt the flashlight to a 60-degree angle. Make sure the flashlight remains at a constant height above the paper (10 centimeters). Students should trace the light on the paper, and estimate the area. Repeat procedure with a 30-degree angle.
3. Last, students should discuss the findings of the spotlight activity with their partner. Ask students to connect this activity with our previous sunray experiment. What do both models show? (Direct and indirect light) Students should write their findings and connections into their science journals.

Assessment Suggestions

- Instruct students to write on an index card how direct and indirect rays correspond to temperature. These cards should be posted on the compare/contrast board to add to students' understanding of the reasons for seasons.
- Sketch a picture of Earth. Draw the rays hitting the equator directly, and continue drawing sunrays showing the curving of sunlight around the North and South Poles. Notice how short and direct the rays are those strikes at Earth's equator compared to the rays that are longer and must curve when they strike Earth near its poles.

Curriculum Extensions/Adaptations/ Integration

a. For advanced learners, allow them to design their own experiment to show the direct and indirect angle of the sun's rays. How would they change or improve the experiment we did in class? Pose this question: How would the seasons change if Earth were NOT tilted on an axis? What would the results of our experiment be if we collected data in the morning, at noon, and near the end of school?

b. For learners with special needs, have them take a picture or draw the sunray collection board. Label each thermometer in the picture with the comparative adjectives: warm, warmer, hot, hotter.

Family Connections

- Students and their families should observe the location of the sun throughout the day. Compare the temperatures during the morning, daytime, evening, and night. Where did they notice the sun in the sky during those times?
- Students practice fluency by reading the seasons information to their family.
- Students collect an index card from at least one adult with the adult's explanation of why the earth has seasons. The students should sort and post these cards onto the compare/contrast board showing accurate information and misconceptions.

Additional Resources

Books

The Seasons of Arnold's Apple Tree, by Gail Gibbons, ISBN 0-15-271246-1

Sun Up, Sun Down, by Gail Gibbons, ISBN 0-15-282782-x

The Reasons for Seasons, by Gail Gibbons, ISBN 0823411745

The Little Island, by Golden MacDonald and Leonard Weisgard, ISBN 0-440-40830-x

Sunshine Makes the Seasons, by Franklyn M. Branley and Michael Rex, ISBN 069004481X

The Real Reasons for Seasons, Great Explorations in Math and Science (GEMS), ISBN 0-924886-45-5

Media

Bill Nye the Science Guy. Earth's Seasons; ISBN 1932644342 9781932644340

Web sites

http://www.enchantedlearning.com/subjects/astronomy/planets/earth/Seasons.shtml

http://www.collinseducation.com/resources/ict%20activity/earth_FULL.swf

http://www.morehead.unc.edu/Shows/EMS/seasons.htm

http://www.nationalgeographic.com/xpeditions/activities/07/season.html

http://www.windows.ucar.edu/tour/link=/the_universe/uts/winter.html&edu=elem

http://www.scienceu.com/observatory/articles/seasons/seasons.html

Organizations

Activities Integrating Mathematics and Science (AIMS)

http://www.aimsedu.org/

Demeter and Persephone: A Reader's Theater

Written by: LuAnn Kluge
Language Arts Specialist, Granite District

Characters:
Narrator 1
Narrator 2
Narrator 3
Demeter
Persephone
Zeus
Hades
Hermes
Boy

Narrator 1: Zeus, the King of the Gods presented Demeter, the goddess of the harvest, grain, and fertility with a beautiful daughter named Persephone. As Persephone was raised among the flowers in the fields of her mother, she began to blossom into a flower herself.

Narrator 2: Persephone was as strong, yet as flexible as the stem of a plant with skin as soft as petals, and beautiful eyes like pansies. She began caring for the flowers in the fields for her mother. She spent her time creating new flowers and giving them names.

Persephone: Mother, I am off to the fields with my paint pot to make the world more glorious with my beautiful flowers.

Demeter: As I am the goddess of planting and harvesting, and a fine lady of growing things, I couldn't be more proud of you, Persephone. My love for you is immense.

Narrator 1: Across a stream, through a grove of trees, and into a little glade, Persephone wandered, a bit further than her normal route had ever taken her.

Narrator 2: Carrying her paint pot, she began giving faces to a stand of tall waxy lilies with her paintbrush. Persephone hummed softly as she worked.

Persephone: (humming) Oh! I haven't ever noticed this strange bush in the meadow before. The leaves are thick, green and glossy. The berries on the branches look like drops of blood. It is ruining the looks of my field of beautiful flowers with its ugliness.

Narrator 1: With a mighty pull, Persephone seized the plant. The bush did not move.

Narrator 2: The strange bush was firmly rooted. However, the young Persephone was used to getting her own way. Again she pulled with all of her might. Up came the bush and with it long roots came dragging out of the ground, leaving a big gaping hole behind.

Narrator 3: Immediately a fierce rumbling began and the gaping hole began spreading and opening like a huge mouth. As the noise grew with great intensity, out leapt six black horses pulling a golden chariot. In the chariot stood a tall figure with a flowing black cape and a black crown on his head.

Hades: (evil laughter) Ha! Ha! Ha! Ha!

Narrator 1: Persephone was snatched away by Hades before she even had time to scream.

Narrator 2: Plunging deep into the hole again, the ground swallowed them up. Just as quickly as the ground had opened, the hole was closed again.

Demeter: Persephone! Persephone! Where are you? (begins to panic) Persephone!

Narrator 3: All night long Demeter searched for Persephone. Only silence answered her.

Narrator 1: As dawn broke across the sky, Demeter came upon an uprooted bush. Leaping from her chariot, she noticed something in the grass that seemed to pierce her heart.

Demeter: (crying) Oh, please….no! It is Persephone's little paint pot. She would never have left her paint pot behind willingly.

Narrator 2: As the sun continued to rise, the birds began chirping. The chirping turned to gossip about the girl, the bush, the hole, the chariot, and the black rider.

Narrator 3: Demeter listened to the birds and wept. She knew Hades, the dark god of the underworld, had captured her lovely Persephone.

Narrator 1: Demeter's sorrow soon turned to furious anger as she fled to Zeus.

Demeter: Zeus! Zeus! Persephone has been captured by Hades and has been taken down to the dark underworld. Until she is returned to me, I will cause a famine to come upon the land. I will see to it that there will be a devastating shortage of food in the land as the plants will all wither and die causing animals and people to starve.

Zeus: Compose yourself, Demeter! This may be a nice arrangement for both Hades and Persephone.

Demeter: Never! Anyone but Hades. This must not be. Persephone is a spring child. She needs sunshine or she will wither and die.

Narrator 2: As Demeter was speaking to Zeus, she noticed Zeus was holding a new thunderbolt. She realized the bearer of the gift was Hades. The gift had been offered in exchange for Persephone. Demeter felt betrayed and defeated.

Demeter: I will return to my Earth.

Narrator 3: Weeks passed. Zeus' sleep was interrupted by loud sighs from Earth below. As he looked down he saw a terrible sight.

Zeus: Nothing is growing! The blazing sun continues to parch the fields, shriveling the wheat, corn, and barley. The soil is hard and cracked. There is no green anywhere. Cattle and people are starving. Something must be done.

Narrator 3: Through their hunger and pain, people lifted their faces to Mount Olympus and prayed for Zeus to help them.

Narrator 1: Zeus sent for Demeter.

Zeus: Do you still wish for your daughter's return?

Demeter: Yes. While she is gone, no crops will grow. No tree will bear. No grass will spring. While she is gone and while I mourn her, Earth will grow dry and shrivel as my heart, and will put forth no green thing.

Zeus: Very well. Your daughter shall be restored to you.

Demeter: Oh! Thank you, Zeus.

Zeus: However, if she has eaten any food while with Hades, she must remain with him. This is the law and even I am powerless to revoke it.

Demeter: No food will have passed her lips. She would have been too sad to eat while she has been away from me.

Zeus: Then, I will send Hermes, the messenger god, to Hades and demand Persephone's release. (calling out) Hermes!

Hermes: Yes, Zeus?

Zeus: You must go to Hades at once with this message, and demand the release of Persephone.

Hermes: My winged shoes will get me there quickly. I am off, Zeus!

Narrator 2: In the meantime, down in the underworld, Persephone had spent her days with the dark king.

Hades: Persephone, your beauty causes a gentleness to come upon me. You are worth more than these rubies and diamonds that I adorn you with.

Persephone: I will not take your gifts. I will never forgive what you have done to me!

Hades: I have had dresses spun of gold and silver for you.

Persephone: I want to go home to my mother!

Hades: Your throne, my lady, is made of the finest ebony and here is a crown of black pearls.

Persephone: I hate you and I always will!

Narrator 3: As Persephone spent her days throwing tantrums at Hades, she was secretly and slowly beginning to enjoy the attention Hades gave her.

Narrator 1: She enjoyed his gifts and his efforts to please her.

Narrator 2: Although she longed for sunshine and flowers, she secretly admired Hades.

Narrator 3: But, Persephone still insisted on pouting and she refused to allow a crumb of food to pass her lips.

Hades: Please eat, Persephone. I have had my cook prepare you the most delicious meals!

Persephone: Never! I will not eat until I am returned to my mother!

Narrator 1: In an effort to please Persephone, Hades gave her some ground in which she could plant a garden.

Narrator 2: Hades gave her rare seeds to plant with magical blooms that did not need sunlight.

Narrator 3: He also gave her a young boy to serve as a helper in her garden. One afternoon as Persephone was gardening she grew especially hungry. It had been so long since she had eaten. She noticed her helper eating something in the distance.

Persephone: Boy, what are you eating?

Boy: (smiling) A juicy, red fruit. It is a pomegranate.

Persephone: I am so hungry.

Boy: We are alone. No one will see you. No one will know. Quickly…….eat!

Persephone: (eating) I have never tasted anything so…delicious…hmmmm, one, two,

Narrator 1: Just as Persephone swallowed the fourth pomegranate seed, a cry that could only be Hermes, the messenger of the gods, split the air.

Narrator 2: Persephone raced to Hades' palace.

Hermes: Good day…Hades…Persephone.

Hades: (scowling) Why are you here?

Persephone: Good day, Hermes!

Hermes: I bring a message from your mother, Persephone. She wants you home. I'm sure you haven't eaten anything during your stay here. (not giving her time to answer) Let's go!

Narrator 3: As the gardener boy rushed to Hades, Persephone and Hermes narrowly escaped.

Boy: Hades, Persephone has eaten four pomegranate seeds!

Narrator 1: By the time Persephone was home, Hades had already been to visit Zeus.

Hades: Persephone has eaten four pomegranate seeds in my kingdom. She must return to me. This is the law, Zeus!

Zeus: That is true, it is the law. Because Persephone ate four seeds of the pomegranate she will return to Hades for four months out of every year.

Demeter: (crying) My heart will break without my Persephone!

Persephone: Don't cry mother! We must be happy for the time that I am here on the earth with you.

Demeter: I will be happy while you are here. Flowers will bloom, grass will grow, and the tree will bear fruit. But, as for the months you are away, as my heart is longing for you, Earth will suffer.

Narrator 1: Because of Demeter's longing for her daughter, we have the seasons of summer and winter.

Narrator 2: Summer is a time for planting and growth. It is the time of Demeter's happiness. Persephone is here on Earth with her mother.

Narrator 3: Winter is a time when Earth sleeps under frost. Winter is Demeter's suffering. Persephone spends this time in Hades' underworld.

Narrator 1: So it remains…year after year as the seasons change from one to another, the law is fulfilled as Persephone returns to Hades four months of every year.

Seasons Brainstorming Chart

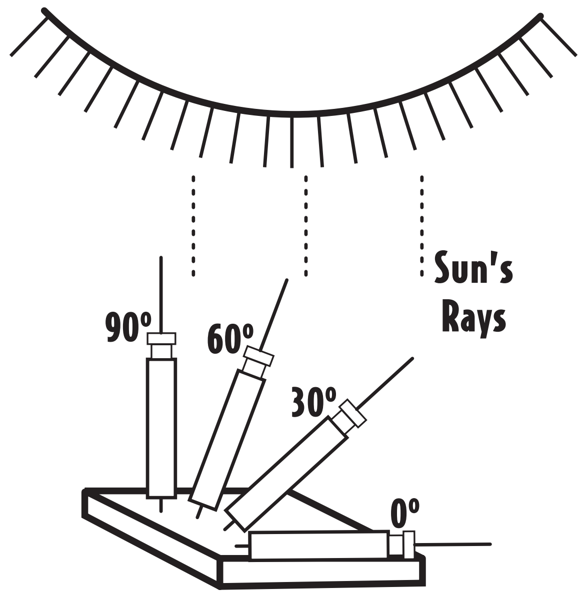
Seasons	Average Temperature	Signs in Nature	People's Activities
winter			
spring			
summer			
fall			

Seasons Brainstorming Chart

Seasons	Average Temperature	Signs in Nature	People's Activities
winter			
spring			
summer			
fall			

Name ______________________________

Sunray Data Collection Sheet



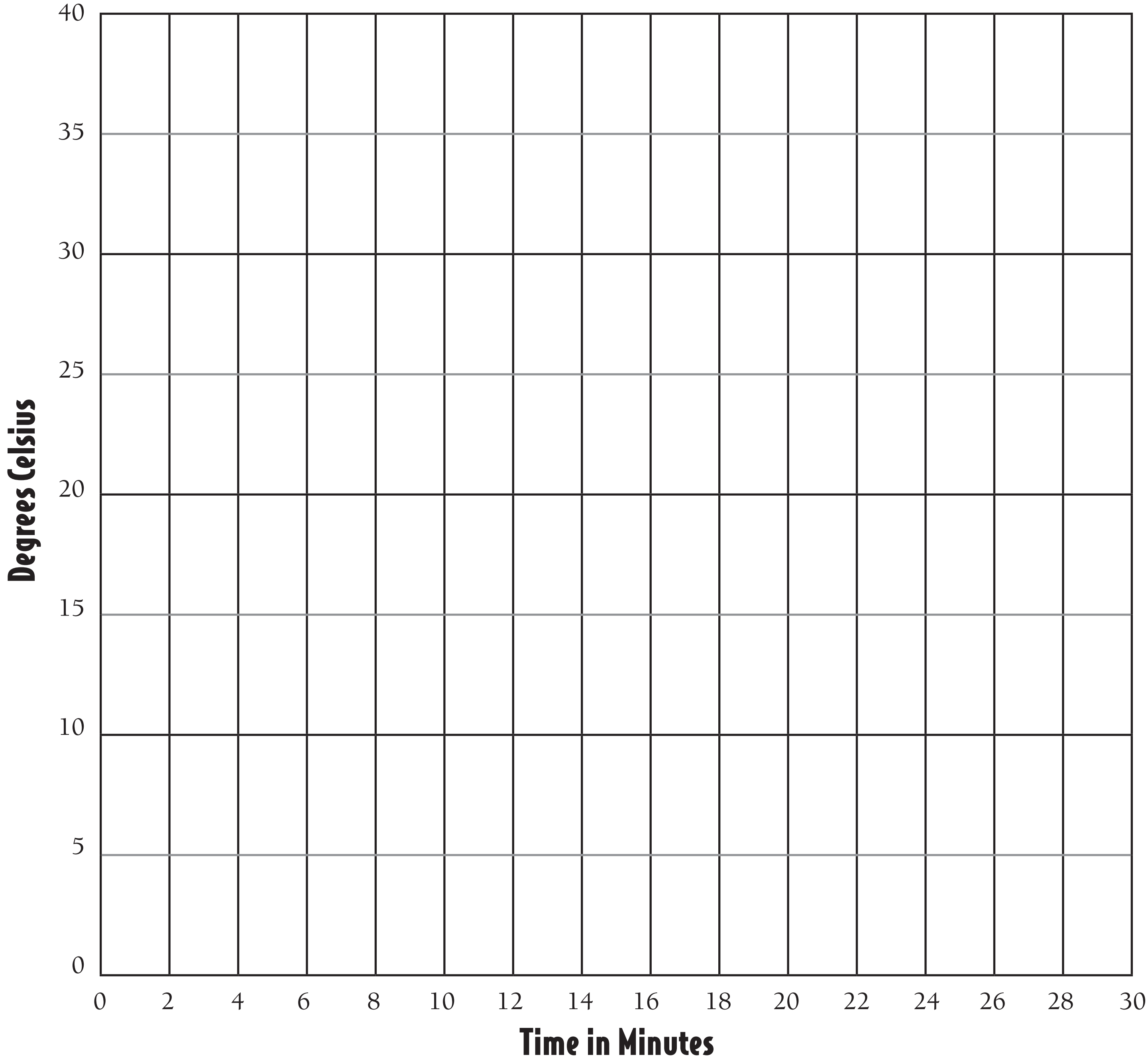
Angle of Thermometer to Sun's Rays

	0 degrees	30 degrees	60 degrees	90 degrees
beginning temperature				
10 minutes				
20 minutes				
30 minutes				
AVERAGE TEMPERATURE				

What did you discover about the angle of the sun's rays and the temperature?

Name ________________________________

Sunray Line Graph

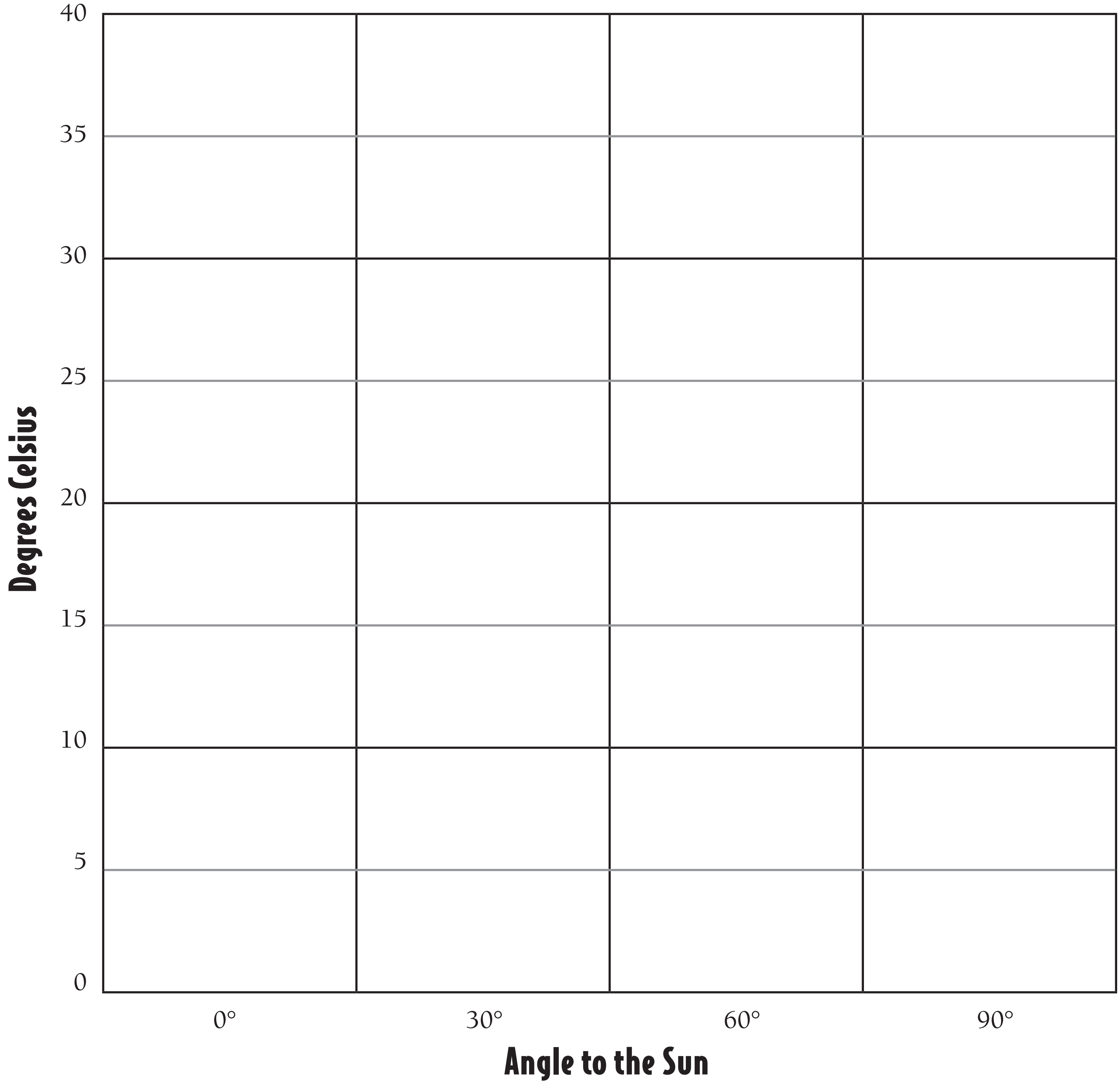


Graph Key

color	angle
	0 degrees
	30 degrees
	60 degrees
	90 degrees

Name ________________________________

Sunray Bar Graph



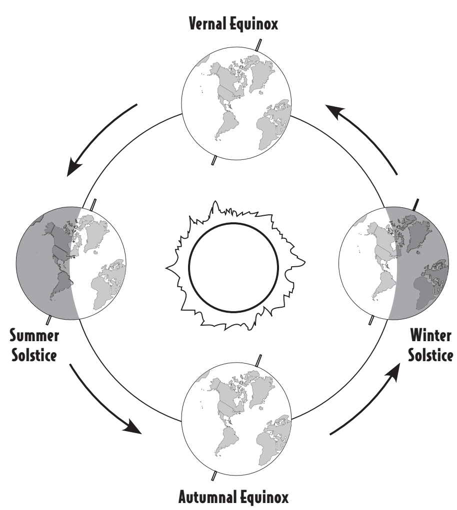
← Least Direct Sunrays

Most Direct Sunrays →

Centimeter Grid Paper

Seasons: The Reasons

0 Spring, summer, autumn, and winter bring changes in the
9 weather, plant and animal life, and the length of days and nights.
21 Seasons change because of three factors. Reason number one: Earth
31 is tilted on its axis to one side. Reason number two: Earth rotates, or
45 turns, on its axis every 24 hours. Reason number three: Earth
56 revolves around the sun once every year.
63 There is an imaginary line that runs through the center of the
75 Earth. This line is called an axis. The two points where the axis
88 passes through the Earth are called poles. The Earth has a North Pole
106 and a South Pole. As the Earth moves around the sun, it spins on its
116 axis. This spinning, called rotation, causes day and night.
125 Our planet is always tilted in one direction – towards Polaris, or
136 the North Star. The North Pole is always tilted towards this star as
149 Earth moves in a path around the sun.
157 Our planet is always moving around the sun in a path called an
170 orbit. This action around the sun is called Earth's revolution. One
181 revolution of Earth takes about 365 days. The days change as Earth
193 orbits the sun. The length of the days changes. The temperatures on
205 Earth also change.
208 In summer, the Northern Hemisphere, where we live, points
217 toward the sun, bringing more direct and powerful sunrays. Summer
227 days are longer, and the sun is higher in the sky. Temperatures rise in
241 the summer.
243 In winter, the Northern Hemisphere is tilted away from the sun.
252 The sun is low in the sky, even at midday. The Earth has the year's
267 fewest daylight hours, and receives the least direct rays from the sun.
279 Winter is a time of short days, long nights, and low temperatures.
291 Because Earth's axis is tilted neither toward nor away from the
302 sun in spring and autumn, equal periods of daylight and darkness result.
314 The directness of the sun's rays are changing, causing warming in
325 spring and cooling in autumn.
330



The Trip Around the Sun

Standard II:

Students will understand how Earth's tilt on its axis changes the length of daylight and creates the seasons.

Objective 2:

Explain how the relationship between the tilt of Earth's axis and its yearly revolution around the sun produces the seasons.

Intended Learning Outcomes:

1. Use Science Process and Thinking Skills
2. Manifest Scientific Attitudes and Interests
3. Communicate Effectively Using Science Language and Reasoning

Content Connections:

Language Arts VII; Comprehension
Math III; Spatial and logical reasoning
Math V; Basic concepts of probability

Science Standard I

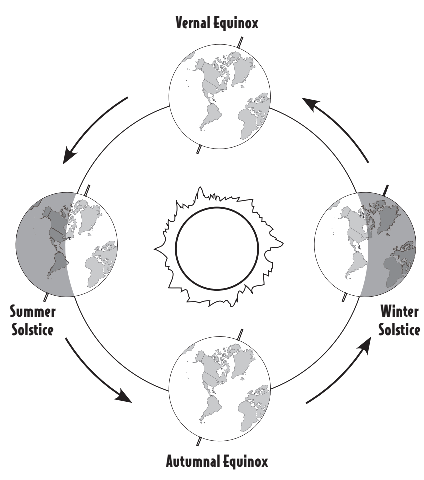
Objective 3

Connections

Background Information

There are many misconceptions about what causes seasons. When people think about Earth's revolution around the sun, many picture a very oval, elliptical shape. Actually, Earth's orbit is a slightly elliptical circle. Thus, the distance between the sun and Earth does not change significantly throughout the year.

Earth spins on its axis, which is what causes day and night. The axis is tilted so that the North Pole points at the North Star, Polaris, all of the time. Because of Earth's tilt and revolution around the sun, each of Earth's poles is tilted towards the sun for part of the year. Consequently, each pole is tilted away from the sun for part of the year. When the Northern Hemisphere is tilted towards the sun, the result is more hours of daylight and more direct sunlight. These two factors create warmer temperatures for the Northern Hemisphere, resulting in the season of summer. When the days are shorter and the sunlight is much less direct, it is the season of winter.



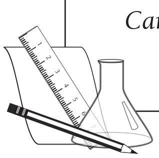
Research Basis

Huitt, W. (2003). Constructivism. Educational Psychology Interactive. Valdosta, GA: Valdosta State University. Retrieved [date], from http://chiron.valdosta.edu/whuitt/col/cogsys/construct.html

The constructivist approach to teaching states that when a student feels safe and secure in his/her learning environment, the processing of new thoughts and ideas will take place. Advocates of constructivism state that it is the stimuli of the environment, rather than the stimuli themselves that most greatly impact student achievement. In most curriculums, knowledge and skills are taught separately and then connected, versus the constructivism-oriented classroom in which students acquire content while carrying out tasks that require higher-order thinking. For example, scientific knowledge is usually taught by working students through information piece by piece, rather than looking at new knowledge from a holistic viewpoint. Teachers need to first consider the knowledge and experiences students bring with them to the lesson. Then, the instruction should be built so that the students can expand and develop new knowledge by connecting it to previous experiences and learning. Teachers should provide a mixture of direct instruction, active practice of the new skill, and feedback. The constructivist approach is centered on a student's pre-existing experiences, filling the gaps and providing ample time, space, experiences, with choice and differentiation for students to display their new knowledge.

Materials

- ❏ *"Why Do We Have Seasons"* song
- ❏ *Seasonal Landmark Cards*
- ❏ Polaris & circumpolar stars poster
- ❏ String
- ❏ Meter sticks
- ❏ Styrofoam
- ❏ Four skewers
- ❏ *Earth Models*
- ❏ Tacks
- ❏ Protractor
- ❏ Art paper
- ❏ *Sunlight Through the Year*
- ❏ Rulers
- ❏ Markers
- ❏ Glue
- ❏ *Reasons for Seasons Assessment Choices*
- ❏ *Seasons Pictionary Cards*



Invitation to Learn

Sing the song *"Why Do We Have Seasons"* with students. This is a simple echo song to the tune of "Charlie Over the Ocean". The teacher sings each line and the students echo back. This simple song includes all essential elements on why Earth has seasons throughout the year.

Instructional Procedures

Part One: The Earth's Movements

1. Find an open area where all students in class can stand in a circle so that everyone can see and hear the teacher and each other easily.
2. Show students a length of string that has been previously measured to be about 2 meters in length. This string represents the distance from the sun to Earth. (The average distance of

Earth to the sun is 150 million kilometers, which scientists call an 'astronomical unit'.) Refer to the string as one astronomical unit.

3. Instruct students to stand around a central point. Choose an object or a student to represent the sun in the center of the circle. Students should face the center of the circle. Use the string to help students create an even, almost circular shape by stretching the string from the central point to each edge of the circle. The students are now in the shape of Earth's yearly revolution around the sun. Explain to the students that they are modeling Earth at various points in its yearly revolution. Ask students to explain to their neighbor and then to the whole group the apparent shape of Earth's orbit in space. (circle) Make a point of noticing that Earth does not appear closer to the center point anywhere in the circle. (Actually, Earth is slightly closer to the sun in January and slightly farther away from the sun in June. However, these slight distances in the huge scale of space do not make any significant differences in Earth's temperature.) When the teacher gives the signal to "Revolve!" the students should start walking in a counter-clockwise motion around the classroom sun.
4. Ask students to demonstrate what Earth does in space each day by turning counterclockwise in place to show rotation. Identify day and night by turning towards and away from the sun. Each time the teacher says "Rotate!" from now on, students should turn around in place once in a counter-clockwise motion.
5. Have students return to their seats and record findings from the model. Pose the following questions to the students: What was the model trying to show? What key vocabulary words need to be used? What does this model help us understand?
6. Students should draw a picture in their science journals of Earth's circular revolution around the sun, and define the words rotation and revolution. Add drawings and helpful reminders to clarify these terms.

Part Two: The Tilt

1. Draw students' attention to the pre-hung poster of the North Star (Polaris) on the wall. Ask students if they know anything about the North Star. Explain to students that one of the reasons the North Star stays in one place throughout the year and can be used as a navigation tool is because Earth's axis is always tilted towards it. Explain to students that no matter

where Earth is in its trip around the sun, the Northern Pole of Earth is always tilted 23.5 degrees towards Polaris.

2. Ask students to imagine that the upper half of their bodies represents Earth. Next, ask students to demonstrate estimating angles by bending their bodies at the waist to degrees called out by the teacher. Start with 90 degrees, go to 60 degrees, 30 degrees, and 0 degrees, the angle measures used in the previous sunray lesson. Make sure students are turned towards the North Star as they are bending, pointing their head (North Pole) consistently at Polaris. Last, students should demonstrate an estimated 23.5-degree tilt towards Polaris. Agree as a group what this tilt might look like.
3. Draw students' attention back to the central object in your model. What is the object that holds Earth in place during its revolution? (The sun.) What force keeps Earth from flying away into space? (The gravitational force from the sun.) Discuss the limitations of the classroom model you are creating. (The scale is not accurate and no energy is coming from our classroom sun.)
4. Students should draw a picture of Earth's tilt towards Polaris in their science journal. Pose these final questions to students: What questions do you have about Earth and the sun in space? Where could the answers to these questions be found? Ask students to meet in teams of three to discuss their journal sketches and wonderings.

Part Three: The Seasons

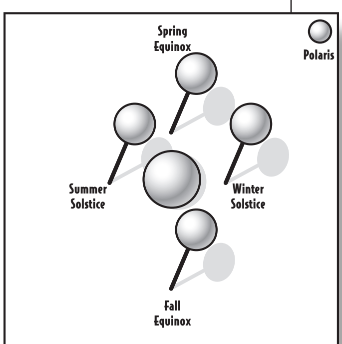
1. As the students are standing in their spots around the sun, explain to students that the sun's energy travels through space and reaches Earth. Ask students to demonstrate the sun's tilt towards Polaris. What part of our circle is tilted towards the sun in the most direct way? Having all students tilt 23.5 degrees towards Polaris and identify the students whose heads are tilted towards the sun. This is the summer section of our circle. Hand one student in the summer section the landmark sign labeled "summer solstice". Briefly describe the summer solstice (June 21st-22nd) as the longest day of the year. This is the day when Earth receives the most hours of daylight from the sun. The sun appears high in the sky as it makes its long trip across the sky. What kinds of temperatures do we experience on summer solstice? What activities would we be doing on summer solstice?

2. Go to the opposite side of the circle from the summer solstice. Ask students to demonstrate Earth's tilt again and point out that this side of the circle is tilted away from the sun (for the Northern Hemisphere). Ask students what season they think it would be if we were tilted away from the sun's energy. (winter) Hand one student the landmark sign labeled "winter solstice". Briefly describe the winter solstice (December 21^{st}-22^{nd}) as the shortest day of the year when Earth receives the least hours of daylight from the sun. The sun appears much lower in the sky as it moves across the sky. What kinds of temperatures do we experience on winter solstice? What activities would we be doing on winter solstice?
3. Ask students to infer what seasons the southern half of Earth is experiencing during the Northern Hemisphere's summer and winter. (The seasons are the opposite because the tilt towards and away from the sun is opposite.) Allow time for students to share personal experiences and connections involving time spent in countries in the Southern Hemisphere.
4. After the summer and winter solstice have been identified and labeled, show students the landmark signs titled "spring equinox" and "fall equinox". Explain to students that spring and fall are in-between seasons, in which the weather is changing from one season to another. Earth is neither tilted towards or away from the sun during these times. Ask students to demonstrate their tilt again, and find the areas of the circle where students are tilted sideways, and not towards or away from the sun. Hand one student the 'spring equinox' sign, and another the 'fall equinox' sign on the opposite side. Briefly explain the dates and the fact that daylight hours will be equal on the equator during these days. If one Earth day is 24 hours, and day and night are equal, how many hours of daylight would Earth experience on an equinox day? Ask students to describe first to a partner and then to the larger group the weather, signs in nature, and activities of spring and fall.
5. Many of the students are not holding signs yet. Ask students to look carefully around the circle at the four identified seasonal landmarks. Show students the stacks of cards labeled for the transitional time between seasons. Instruct all students who do not yet have a card to carefully decide which sign would best describe the seasonal time they represent. (summer to fall, fall to winter, winter to spring, & spring to summer) Students should make their decision and then move to collect their sign and return to the circle. As students hold their cards up in

front of their chests, it is easily assessed whether any mistakes have been made and can be corrected.

6. This demonstration can be quickly replicated on numerous days throughout the school year by using the cards and a central point. With practice, students will be able to quickly and accurately create a model of Earth's orbit around the sun, demonstrate earth's constant tilt towards Polaris, and identify the seasons throughout the year.
7. Students should sketch a picture of Earth revolving around the sun with the four seasonal landmarks labeled and described in their science journals.

Part Four: Creating a Paper Seasonal Model



1. After creating the human model of Earth's yearly revolution, students will next work in teams of four to create a smaller scale model in which the four seasonal landmarks are identified using the Styrofoam board and skewers from the sunray lesson, along with four paper models of Earth.
2. Students should lightly make a line diagonally from opposite corners of their Styrofoam board to identify a central point. At the central point, students should place a tack.
3. Next, measure and cut a piece of string or yarn that approximately 15 centimeters long. This length will represent one astronomical unit. Poke the tack through one end of the string and hold it in place at the center of the Styrofoam. Use the string to guide the pencil around the central point to make a model of Earth's elliptical, circular revolution through space around the sun.
4. Now, color and cut out the four models of Earth. Tape each model to the end of each skewer.
5. By placing a protractor on the Styrofoam, students measure a 23.5-degree angle towards the classroom 'Polaris' and poke the skewers into the Styrofoam in the four seasonal landmark positions around the sun. Which Earth is tilted towards the sun (tack in the center) with its Northern Hemisphere? Label this skewer 'summer solstice'. Label the opposite Earth model, which has its Northern Pole tilted away from the sun 'winter solstice'. Review dates and attributes of these days. Have groups identify the correct position for their 'spring equinox' and 'fall equinox' Earth models and label them. Review dates and attributes of these days.

6. Students should write descriptive sentences about the four seasonal landmarks in their science journals. Include the vocabulary words direct and indirect sunlight in descriptions.

Part Five: Graphing the Sunlight

1. Lay a piece 9" x 13" art paper horizontally so that it forms a long, thin strip. Starting on one edge, measure and make a mark with your pencil at every 3 centimeters. These marks will be the months of the year. Label each mark with the abbreviation of each month. The extra space at the end of the paper will be used later as a tab to glue the paper into a circle.
2. Using the *Hours of Sunlight Data Chart,* measure a line straight up from each month's tick mark. Make one centimeter equal to one hour of sunlight. After all lines are complete, connect the tops of each line. Shade in the area below the line with a yellow color. The shaded space represents the hours of sunlight that Earth receives throughout the year.
3. Finally, glue the edge of the paper to the opposite side to make the paper into a circle. Stand the circle of graphed sunlight in the center of the Styrofoam model of the seasons. As students look at their model from the side, turn the circled paper so that the months on the paper correspond correctly with the models of Earth on the skewers. Ask students to generalize as a group what they notice about how the hours of sunlight change throughout the year and how this affects Earth's seasons.
4. Students should record the hours of sunlight graphing activity in their science journals.
5. Pose questions to students for discussion and journaling: What does your graph of the sunlight show? How does the hours of sunlight Earth receives connect to the seasons?

Assessment Suggestions

- Students will write on an index card to explain the reasons for seasons. Post cards on the compare/contrast board involving accurate information and misconceptions.
- Students will make a choice from the *Reasons for Seasons Choice Board* to demonstrate their scientific knowledge of seasons.
- Students will participate in a game of 'scientific pictionary' to demonstrate key seasonal vocabulary and concepts.

Curriculum Extensions/Adaptations/ Integration

- For advanced learners, pose 'what if' questions to students to stimulate hypothetical thinking. What if Earth were not tilted? What if Earth revolved every 100 days? What if Earth did not rotate?
- For learners with special needs, ask students to create a simple foldable which shows the position of Earth in the four seasons throughout the year. Each picture should be labeled with the correct heading and with at least three descriptive phrases underneath. (summer solstice: hot, long days, more sun)

Family Connections

- Students should ask 5 adults if they can explain the real reason for Earth's seasons. Bring data collected to school and compile as a class the number of adults who have misconceptions. Add this information to the classroom compare/contrast board.
- Students and families should plan a significant way to 'celebrate' one of the seasonal landmarks. (Get everyone in your family to say "Happy Winter Solstice!" on December 21st.)

Additional Resources

Books

The Seasons of Arnold's Apple Tree, by Gail Gibbons, ISBN 0-15-271246-1

Sun Up, Sun Down, by Gail Gibbons, ISBN 0-15-282782-x

The Reasons for Seasons, by Gail Gibbons, ISBN 0823411745

The Little Island, by Golden MacDonald and Leonard Weisgard, ISBN 0-440-40830-x

Sunshine Makes the Seasons, by Franklyn M. Branley and Michael Rex, ISBN 069004481X

The Real Reasons for Seasons, Great Explorations in Math and Science (GEMS), ISBN 0-924886-45-5

Media

Bill Nye the Science Guy. Earth's Seasons; ISBN 1932644342 9781932644340

Web sites

http://www.enchantedlearning.com/subjects/astronomy/planets/earth/Seasons.shtml

http://www.collinseducation.com/resources/ict%20activity/earth_FULL.swf

http://www.morehead.unc.edu/Shows/EMS/seasons.htm

http://www.nationalgeographic.com/xpeditions/activities/07/season.html http://www.windows.ucar.edu/tour/link=/the_universe/uts/winter.html&edu=elem

http://www.scienceu.com/observatory/articles/seasons/seasons.html

Organizations

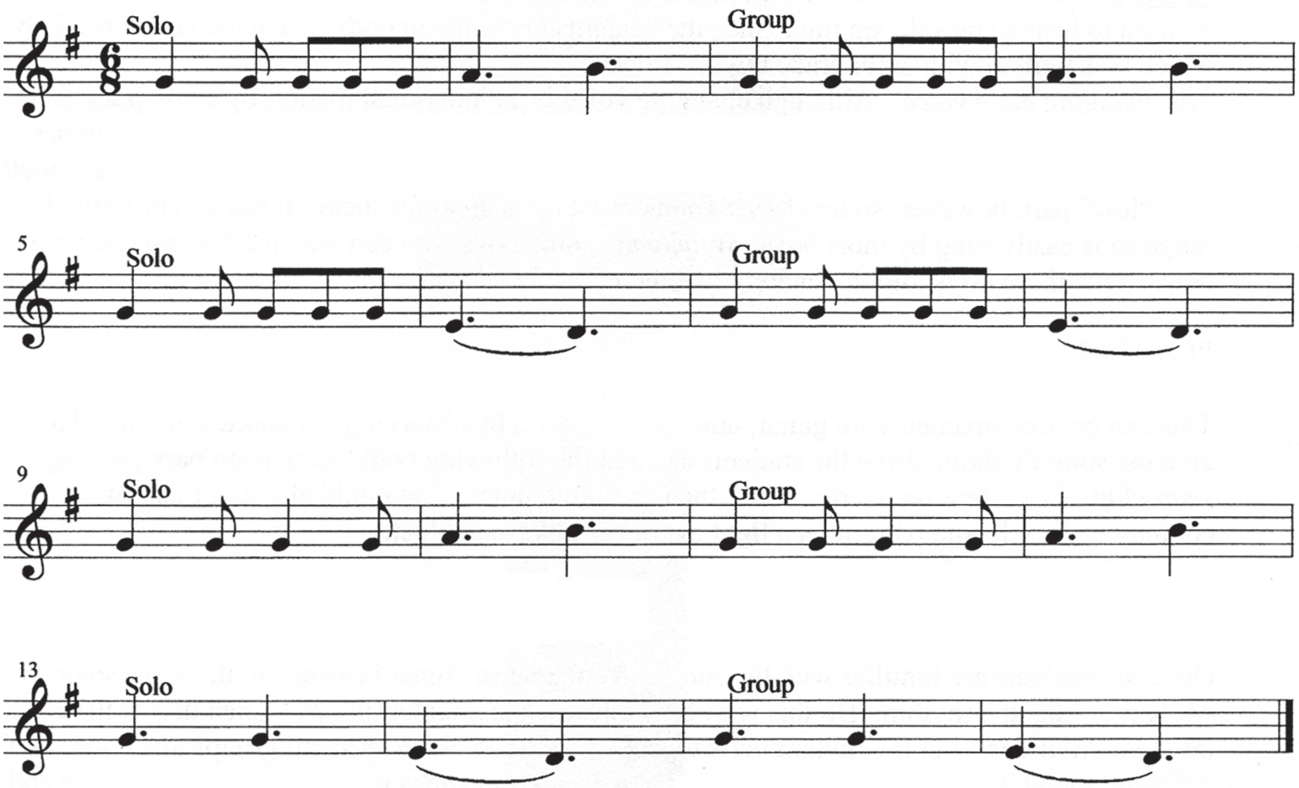
Activities Integrating Mathematics and Science (AIMS)

http://www.aimsedu.org/

Clark Planetarium

http://www.spacescience.org/education/instructional_materials.html

Music for Why Do We Have Seasons



Why Do We Have Seasons

(A Song Sung to the Tune of 'Charlie Over the Ocean')

Why do we have seasons?
(echo)
The Earth tilts and revolves.
(echo)
First we blamed the Greek gods,
(echo)
Now the mystery's solved.
(echo)

The tilting of the axis,
(echo)
points us toward the North Star.
(echo)
Earth rotates every day,
(echo)
& that's what causes light and dark.
(echo)

Revolving 'round the sun,
(echo)
the seasons start to change.
(echo)
Direct and indirect energy
(echo)
heat and cool our days.

Why do we have seasons?
(echo)
The Earth tilts and revolves.
(echo)
First we blamed the Greek gods,
(echo)
Now the mystery's solved.
(echo)

Winter Solstice

December 21st

The first day of winter and the shortest day of the year.

Summer Solstice

June 21st

The first day of summer and the longest day of the year.

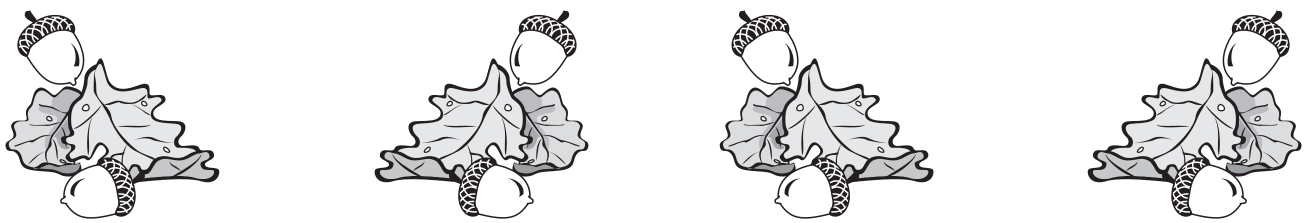
Spring Equinox

March 21st

The first day of spring. Daytime and nighttime hours are equal.

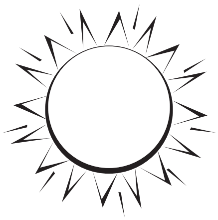
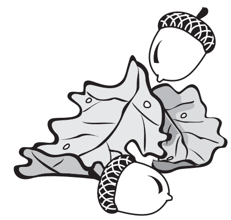
Fall Equinox

September 21st



The first day of fall (autumn). Daytime and nighttime hours are equal.

Summer to Fall

 **The days are** 
getting shorter, the sun appears lower in the sky, and the temperatures are dropping.

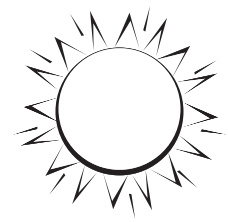
Fall to Winter

 **The days are**  **getting shorter, the sun appears lower in the sky, and the temperatures are dropping.**

Winter to Spring

 **The days are**  **getting longer, the sun appears higher in the sky, and the temperatures are rising.**

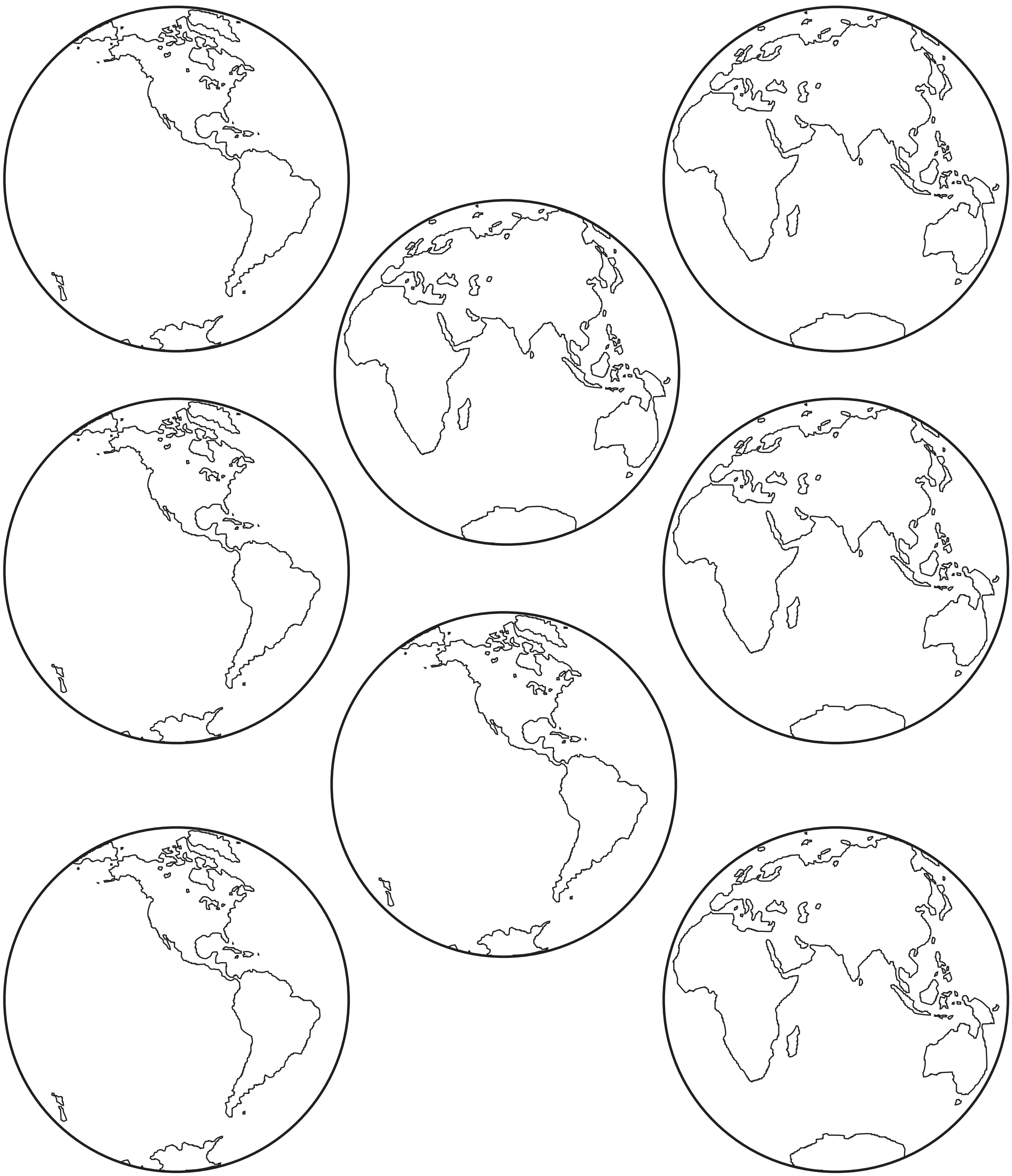
Spring to Summer

 **The days are**  **getting longer, the sun appears higher in the sky, and the temperatures are rising.**

Earth Models

Western Hemisphere

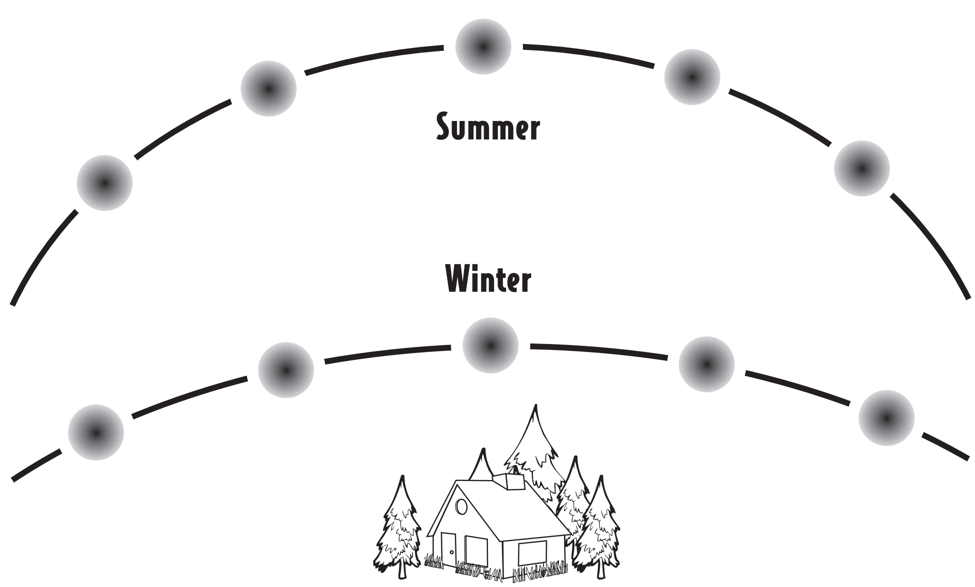
Eastern Hemisphere



Sunlight Through the Year – Salt Lake City, Utah

January	9 hours 30 minutes
February	10 hours 30 minutes
March	12 hours
April	13 hours
May	14 hours 30 minutes
June	15 hours
July	15 hours
August	14 hours
September	12 hours 30 minutes
October	11 hours
November	10 hours
December	9 hours

source: http://www.sunrisesunset.com/calendar.asp



Reasons for Seasons Assessment Choices

Standard II: Students will understand how Earth's tilt on its axis changes the length of daylight and creates the seasons.
Objective 2: Explain how the relationship between the tilt of Earth's axis and its yearly revolution around the sun produces the seasons.

Science Language to Use: Earth's tilt, seasons, axis of rotation, orbit, revolution

The Reasons for Seasons
Show What You Know!

Choose one of the following assessment choices to show your knowledge of why Earth has changing seasons each year.

Write a one page explanation to help a younger classmate understand the reason Earth has seasons each year.	Write and perform a creative skit describing the reasons for seasons. You may work alone or with a group. (no larger than three students.)
Write and perform a song or rap describing the reasons for seasons. You may work alone or with a partner.	Write a poem that explains the reasons for seasons. Plan to read your poem for the class, or publish the poem in the classroom for others to read.
Draw and label a detailed, scientific drawing explaining the reasons for seasons. Plan to post your drawing in the room for others to view.	Create a multimedia product illustrating the reasons for seasons. Plan to show your product to the class.

Seasons Pictionary Cards

Directions: Form teams with students in the class. One person from the first team comes to the board to draw a Seasons Pictionary card. The students must draw a scientific picture to represent the term on their card. The first team tries to guess what their teammate is drawing. The guessing team gets one minute to figure out the seasonal term their teammate is drawing. If the card is not solved, the other team gets a chance to guess the solution. Play continues, altering teams each turn. Cards that are drawn and solved within the time limit earn a point.

rotation	revolution
tilt	axis
Polaris (North Star)	Northern Hemisphere

Southern Hemisphere	Equator
North Pole	South Pole
sun	Earth
summer solstice	winter solstice

spring equinox	fall equinox
daytime	nighttime
direct sunlight	indirect sunlight

Circumpolar Stars Around Polaris

The Big Dipper is an asterism that makes up part of the constellation of Ursa Major (The Big Bear). It is seen here at the lower left of the image. The Little Dipper, part of the constellation of Ursa Minor (The Little Bear), is seen at the upper right. Polaris, the North Star, is at the end of the handle of the Little Dipper.

The two stars at the end of the bowl of the Big Dipper, Merak and Dubhe, are called the “Pointer Stars” because a line drawn between them points to Polaris.

The Big Dipper is a circumpolar constellation for most of the United States. This means it stays above the horizon all night long as it apparently rotates slowly counterclockwise during the night around Polaris due to the Earth’s rotation. It is also comprised of very bright stars in an easy-to-locate pattern. The Little Dipper, on the other hand, is comprised of fairly faint stars that do not really stand out, except for second-magnitude Polaris.

Directions: Copy the Big and Little Dipper patterns onto an overhead transparency. Project the pattern onto large paper and trace the stars in each constellation. Hang the poster in your room on a north-facing wall.

Source: http://www.astropix.com/HTML/SHOW_DIG/038.HTM